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CONTENTS

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A synopsis of *Peristrophe* (Acanthaceae) in southern Africa

K. BALKWILL*

Keywords: Acanthaceae, *Peristrophe*, southern Africa, synopsis, taxonomy

ABSTRACT

A synopsis of *Peristrophe* Nees (Acanthaceae) in southern Africa is provided. *Peristrophe* comprises nine species, one with two subspecies in southern Africa. A key for identification and descriptions of species not included in recent literature are provided. Morphology of tertiary bracts, indumentum on stems and distribution is illustrated and diagnostic characters, distribution, habitat, flowering time and conservation status are discussed for each species.

INTRODUCTION

I undertook a revision of *Peristrophe* Nees in southern Africa (Balkwill 1985) and while doing so, published an account of the *Peristrophe grandibracteata* complex (Balkwill *et al.* 1988) and some new species (Balkwill *et al.* 1985; Balkwill & Getliffe Norris 1989). I thought that the discussions under these species and that of Brummitt (Wood *et al.* 1983: 451) clarified the fate of previously recognised species, but from Welman (1993), it seems that this is not the case. At present, no satisfactory key to the southern African species is available in the literature and there is likely to be a long delay before further accounts of Acanthaceae are published in the *Flora of southern Africa* series. I have therefore decided that it would be constructive to publish a synopsis to aid in the identification of species of this genus.

Peristrophe *Nees* in Wall., Plantae Asiaticae Rariores 3: 112 (1832); Endl.: 707 (1839); Meisn.: 297 (1840); Nees: 374 (1841); Nees: 492 (1847); Harv.: 286 (1868); Benth. & Hook.f.: 1071 (1876); C.B.Clarke: 554 (1885); Lindau: 331 (1895a); C.B.Clarke in Burkill & Clarke: 242 (1899); C.B.Clarke: 84 (1901); Hutch. & Dalziel: 264 (1936); Heine: 424 (1963); Agnew: 609 (1974); R.A.Dyer: 593 (1975). Type species: *Peristrophe baphica* (Spreng.) Bremek. in Nova Guinea new ser. 8: 149 (1957) [= *P. tinctoria* (Roxb.) Nees comb. illeg.].

Suffruticose annuals or evergreen perennials up to 2 m high. *Leaves* petiolate, simple, opposite, widely ovate to lanceolate, acuminate to acute, entire, attenuate at base, herbaceous, usually with eglandular trichomes, especially on midrib. *Inflorescence* of monochasial cymes (inflorescence units) enclosed by a pair of tertiary bracts, with (1)2 or 3(4) inflorescence units umbellately arranged, often compounded. *Bracts*: secondary bracts 2, free, narrowly triangular to lanceolate, sessile or leaflike; tertiary bracts lanceolate to broadly ovate, acuminate. *Flowers* perfect, zygomorphic, occasionally cleistogamous. *Calyx* with short tube and lanceolate lobes, margins usually membranous, inner surface pubescent, trichomes appressed and eglandular. *Corolla* bilabiate, resupinate; tube narrowly cylindric below, subcampanulate above, with 2 pairs of longitudinal hairy ridges within, with eglandular and sometimes glandular trichomes without; lip in lower position elliptic or ovate, minutely emarginate; lip in upper position narrowly elliptic, 3-fid; flowers lilac to purple, occasionally white, with dark purple honey guides on white background on lip in upper position. *Stamens* 2, exserted; filaments epipetalous, linear, usually white or yellow; anthers bithecous, thecae superposed and separated, approximated or slightly overlapping, introrse, purple. *Disc* shallowly cupular, with two small awns, nectariferous. *Gynoecium* bicarpellate; stigma bilobed; style exserted, filiform, glabrous to sparsely strigose; ovary superior, with septum in median longitudinal axis, ovoid or ellipsoid, bilocular, with two ovules in each locule. *Fruit* a stipitate capsule, clavate or obtrullate, placentae inelastic at the bases and bearing retinacula, dehiscing loculicidally. *Seeds* discoid, usually 2 in each locule, rough and tuberculate.

The genus *Peristrophe* occurs in Africa and the East Indies and comprises about 25 species, of which nine occur in southern Africa. *Peristrophe* is very closely related to *Dicliptera* Juss. and differs only in the nature of the placental bases, which are inelastic in *Peristrophe* and elastic in *Dicliptera*. Some workers have tried to apply other characters (e.g. width of the tertiary bracts) as generic characters, and this has led to the incorrect classification of species such as *P. angolensis* (S.Moore) K.Balkwill, *P. transvaalensis* (C.B.Clarke) K.Balkwill and *P. hereroensis* (Schinz) K.Balkwill, all of which were described in the genus *Dicliptera*. Another species that has been confused with *Dicliptera* is *P. bivalvis* (L.) Merr., which has been confused with *Dicliptera foetida* (Forssk.) Blatt. (Wood *et al.*1983). In southern Africa, the shape and venation of the tertiary bracts, if used simultaneously, can act as a guide to the genera. The tertiary bracts of the southern African species of *Peristrophe* are either narrow and single-veined, or if broad, then the veins are pinnate and the secondary veins are reticulate near the margins (Figure 1), whereas the bracts of *Dicliptera* are 3-, 5- or even 7-veined from the base and

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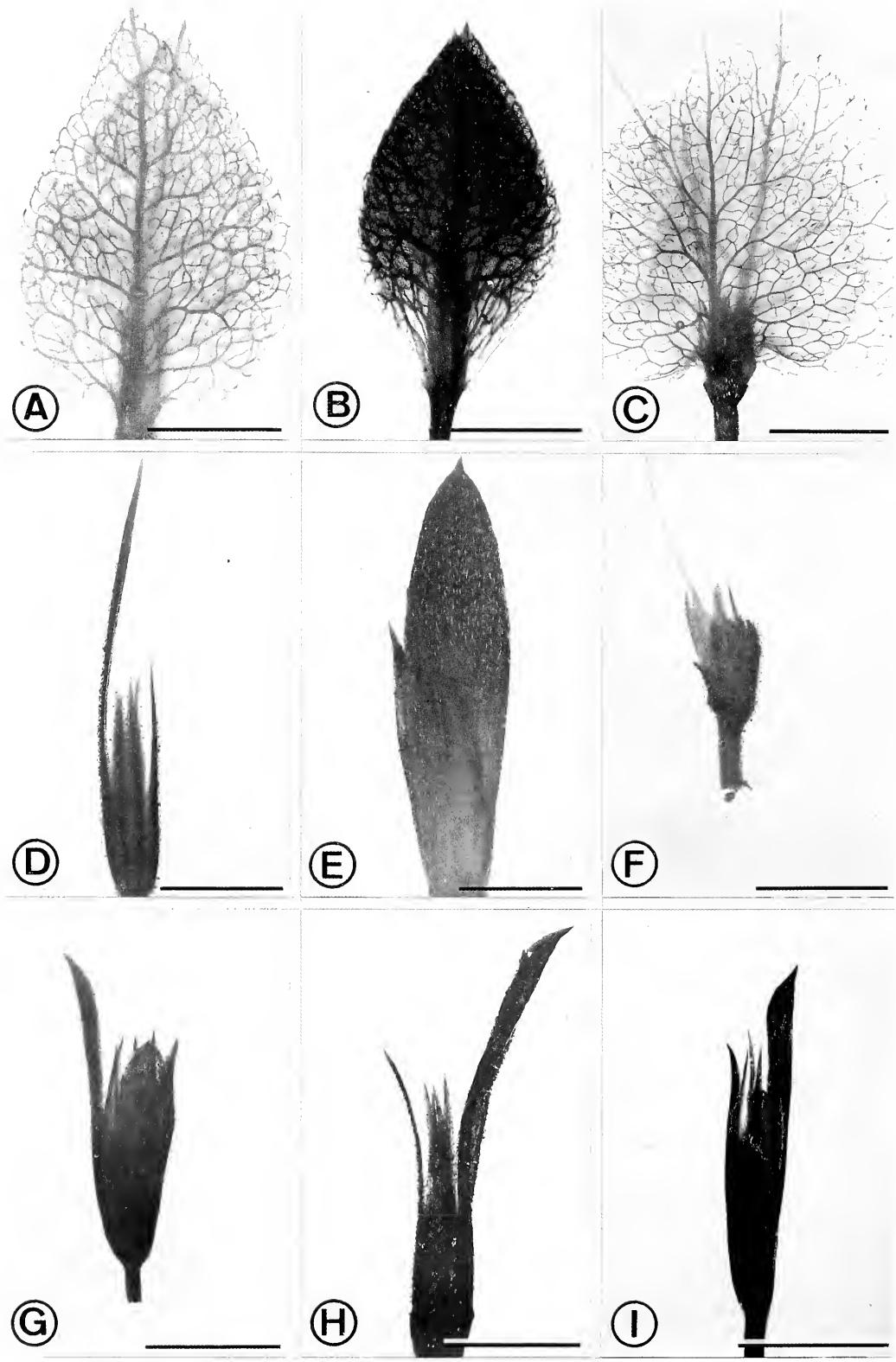

FIGURE 1.—Inflorescence units of southern African species of *Peristrophe*, illustrating tertiary bracts. A, *P. grandibracteata*, *Muller 1311* (WIND); B, *P. hereroensis*, *De Winter 2356* (PRE); C, *P. namibiensis*, *De Winter & Leistner 5828* (WIND); D, *P. paniculata*, *Goldblatt 1929* (NBG); E, *P. transvaalensis*, *Balkwill 764* (J); F, *P. cliffordii*, *Balkwill 793* (J); G, *P. gillilandiorum*, *Bruce 58* (K); H, *P. cernua*, *Balkwill 168* (J); I, *P. decorticans*, *Balkwill 801* (J). Scale bar: 4 mm.

the secondary veins do not form conspicuous reticulations near the margins.

Nees (1832, 1847), recognised two sections in *Peristrophe* and subdivided the first of these into two subsections, but he did not name the sections or subsections. Since that time, three species of *Peristrophe* have been described from Namibia and these do not belong in the groups described by Nees. Thus, it seems that Nees's (1847) first section comprises three groups, but these three groups are sufficiently different to be recognised at the rank of section. The species of *Peristrophe* in southern Africa belong to two of these groups (referred to as sections 2 and 3 below). It would be premature to formally describe these sections here, before a modern and monographic account of the genus has been completed.

Section 1: *inflorescence* of two to seven monochasial cymes (inflorescence units) umbellately arranged, 'umbels' sometimes compounded. *Tertiary bracts* spathulate, ovate to obovate, with three, five or seven veins from the base, remaining green when mature. *Capsule* clavate.

Included species (none southern African): *P. baphica* (the type of the genus), *P. montana* Nees and *P. speciosa* Nees.

Section 2: differs from Section 1 by having only two inflorescence units in each 'umbel'; a single primary vein from the base of the tertiary bracts; tertiary bracts that have conspicuous secondary veins and become membranous when mature (Figure 1A–C); and capsules that are obtrullate in profile.

Inflorescence of monochasial cymes (inflorescence units), usually two umbellately arranged. *Tertiary bracts* ovate to widely ovate, 9.1–14.4 × 6.1–13.8 mm, with a single vein from the base, becoming membranous when mature. *Capsule* obtrullate in profile.

Included species (all southern African): *P. grandibracteata*, *P. hereroensis* and *P. namibiensis*.

Section 3: differs from Sections 1 and 2 by the narrower, less conspicuous tertiary bracts, which are lanceolate to oblanceolate (not ovate to broadly ovate) and narrower than 4 mm (Figure 1D–I) and from Section 2 by the tertiary bracts that are green (not membranous and conspicuously veined) at maturity and by having clavate (not obtrullate) capsules.

Inflorescence of monochasial cymes (inflorescence units), usually 3–4 umbellately arranged, often compounded. *Tertiary bracts* lanceolate to oblanceolate, 3.0–18.0 × 0.4–3.2 mm, green. *Capsule* clavate.

Included southern African species: *P. cernua*, *P. cliffordii*, *P. decorticans*, *P. gillilandiorum*, *P. paniculata* and *P. transvaalensis*.

Key to the southern African species of *Peristrophe*

1a Tertiary bracts broader than 5 mm, veins pinnate, secondary veins forming reticulation at bract edges; capsules obtrullate in profile: Section 2:
2a Secondary bracts leaflike, longer than 7 mm; tertiary bracts widely cuneate at base; leaves lanceolate, length : breadth ratio more than 2.4 : 1:
3a Young stems appearing white, densely pubescent with eglandular trichomes with enlarged, ornamented terminal cells . . . . 1. *P. grandibracteata*
3b Young stems appearing green, not densely pubescent, trichomes without enlarged terminal cells . . . . 2. *P. hereroensis*
2b Secondary bracts not leaflike, shorter than 7 mm; tertiary bracts reniform or cordate at base; leaves ovate to widely ovate, length : breadth ratio smaller than 2.4 : 1:
4a Leaf length : width ratio less than 1.75 : 1; tertiary bract length : breadth ratio less than 1.25 : 1; capsules pubescent . . . . 3.1. *P. namibiensis* subsp. *namibiensis*
4b Leaf length : width ratio greater than 1.75 : 1; tertiary bract length : breadth ratio greater than 1.25 : 1; capsules glabrous . . . . 3.2. *P. namibiensis* subsp. *brandbergensis*
1b Tertiary bracts narrower than 4 mm, with a midrib only, or if more veins present, then not forming reticulation at edges of bract; capsules clavate: Section 3:
5a Corolla 6–14 mm long; plant annual, up to 2 m high; rootstock not woody and seldom branched . . . . 4. *P. paniculata*
5b Corolla longer than 14 mm; plant suffruticose perennial, up to 1.2 m high; rootstock woody and often branched:
6a Tertiary bracts longer than 14 mm and length : breadth ratio less than 6.2 : 1 . . . . 5. *P. transvaalensis*
6b Tertiary bracts shorter than 13 mm, but if longer, then length : breadth ratio greater than 6.2 : 1:
7a Mature stems densely pubescent between ridges; found in the Limpopo River valley:
8a Tertiary bracts up to 5 mm long, length : breadth ratio less than 6 : 1 . . . . 6. *P. cliffordii*
8b Tertiary bracts longer than 7 mm, length : breadth ratio greater than 7 : 1 . . . . 7. *P. gillilandiorum*
7b Mature stems glabrous or sparsely pubescent between ridges or not found in the Limpopo River valley:
9a Occurring in Zimbabwe, Botswana and Northern Province; lip in lower position (6.5)–7.5–9.2–(10.2) mm long . . . . 8. *P. decorticans*
9b Occurring in KwaZulu-Natal and Eastern Cape; lip in lower position (7.2)–9.8–16.5–(22.3) mm long . . . . 9. *P. cernua*

SECTION 2

1. **P. grandibracteata** *Lindau* in Botanische Jahrbücher 49: 404 (1913); P.G.Mey.: 49 (1968), p. p.; K.Balkwill et al.: 48 (1988). Type: Namibia, Kuibis, (–DB), *Range 613* (SAM!, lecto., designated by Balkwill et al.: 48 (1988); BOL!).

Diagnostic characters: densely white hairy stems (Figure 2A) and broad bracts (Figure 1A). *Distribution*: southern Namibia, south of 24° latitude and west of 18° longitude (Figure 3). *Habitat*: deep sandy soils and dry rocky slopes in the Namib Desert and Bushy Karoo-Namib shrubland (White 1983). *Flowering time*: April to June. *Conservation status*: although not highly localised, *P. grandibracteata* is known from only five specimens,

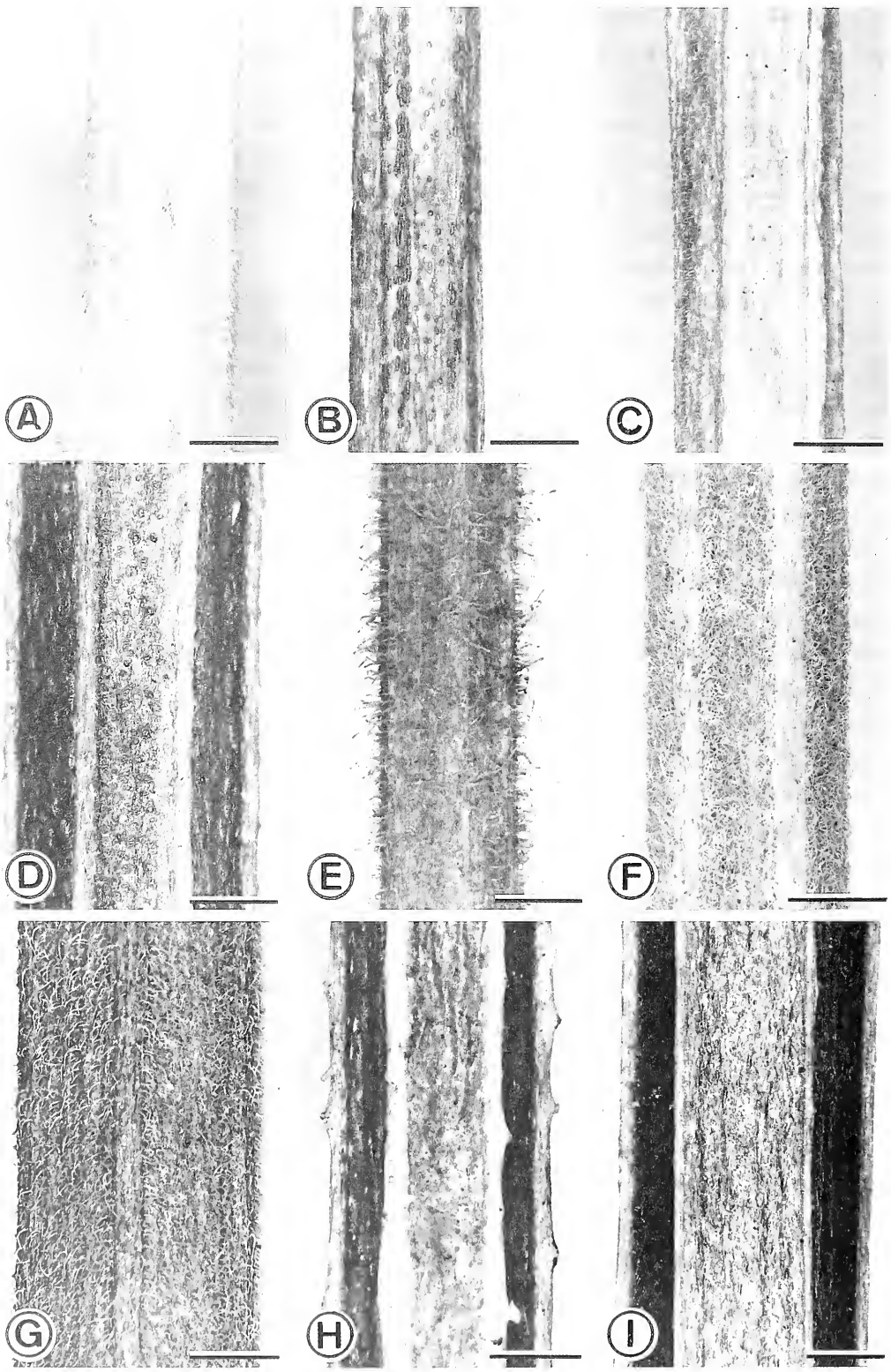

FIGURE 2.—Indumentum on stems of southern African species of *Peristrophe*. A, *P. grandibracteata*, *Muller 1311* (WIND); B, *P. hereroensis*, *De Winter 2356* (WIND); C, *P. namibiensis*, *De Winter & Leistner 5828* (PRE); D, *P. paniculata*, *Goldblatt 1929* (NBG); E, *P. transvaalensis*, *Balkwill 764* (J); F, *P. cliffordii*, *Balkwill 793* (J); G, *P. gillilandiorum*, *Bruce 58* (K); H, *P. cernua*, *Balkwill 168* (J); I, *P. decorticans*, *Balkwill 801* (J). Scale bar: 1 mm.

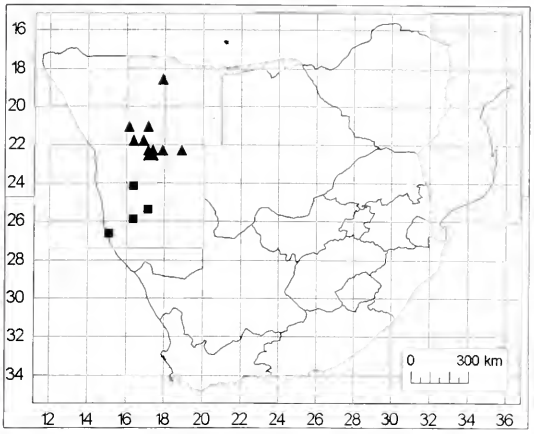

FIGURE 3.—Distribution of *Peristrophe grandibracteata*, ■; *P. hereroensis*, ▲.

suggesting it is rare and its conservation status requires investigation.

2. **P. hereroensis** *(Schinz) K.Balkwill* in Getliffe Norris et al. in South African Journal of Botany 51: 489 (1985); K.Balkwill et al.: 48 (1988). Type: Namibia, Otjihua, (–BB), *Dinter 459* [Z!, lecto., designated by Balkwill et al.: 48 (1988), 2 sheets; GRA! K!, SAM!].

Dicliptera hereroensis Schinz in Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich 61: 438 (1916).

Diagnostic characters: *P. hereroensis* can be distinguished from *P. grandibracteata* by its green stems with sparse eglandular hairs (Figure 2B) rather than white stems with dense ornamented eglandular hairs. It differs from *P. namibiensis* by the tertiary bracts that are widely cuneate at the base (Figure 1B) (not reniform or cordate), secondary bracts that are longer than 7 mm (not shorter than 6 mm) and by the narrower leaves [length : breadth ratio greater than (not less than) 2.4 : 1]. *Distribution*: northern Namibia (Figure 3). *Habitat*: on various kinds of soils, usually in the shade of trees of *Acacia*, in Kalahari *Acacia* wooded grassland and deciduous bushland and the Kalahari/Karoo-Namib transition (White 1983). *Flowering time*: between November and July, with a peak in March and April. *Conservation status*: *P. hereroensis* is known from 17 collections from a number of different localities. It is unlikely to be rare or threatened.

3. **P. namibiensis** *K.Balkwill* in Balkwill et al. in South African Journal of Botany 54: 52 (1988). Type: Namibia, Farm Blässkranz (REH 7), Berghang, (–AC), *Merxmüller & Giess 28127* (PRE, holo.!; WIND!).

Diagnostic characters: *P. namibiensis* differs from *P. grandibracteata* by its green (not white) stems and from *P. grandibracteata* and *P. hereroensis* by its much smaller secondary bracts that are not leaflike and by its cordate tertiary bracts (Figure 1C).

3a. subsp. **namibiensis**

Diagnostic characters: leaf length : width ratio of less than 1.75 : 1; tertiary bract length : breadth ratio of less than 1.25 : 1; and pubescent capsules distinguish subsp. *namibiensis*. *Distribution*: southern half of Namibia (Figure 4). *Habitat*: on dolomite koppies (and possibly other habitats) in the Kalahari/Karoo-Namib transition and Namib Desert (White 1983). *Flowering time*: April to August. *Conservation status*: this taxon is known from only five collections, suggesting that its conservation status requires investigation.

3b. subsp. **brandbergensis** *K.Balkwill* in Balkwill et al. in South African Journal of Botany 54: 52 (1988). Type: Namibia, Outjo Farm OU 516, Sandsteinruecken, *Giess & Barnard 7921* (WIND, holo.!; NBG!, PRE!).

Diagnostic characters: leaf length : width ratio greater than 1.75 : 1; tertiary bract length : breadth ratio greater than 1.25 : 1; and glabrous capsules distinguish subsp. *brandbergensis*. *Distribution*: northern half of Namibia (Figure 4). *Habitat*: Bushy Karoo-Namib shrubland and Namib Desert (White 1983). *Flowering time*: April to August. *Conservation status*: this taxon is known from nine collections (some quite recent) from a number of localities; it is unlikely to be threatened.

SECTION 3

4. **Peristrophe paniculata** *(Forssk.) Brummitt* in Wood et al. in Kew Bulletin 38: 451 (1983). Type: Yemen, *Forsskål 385* [C, designated by Brummitt (Wood et al. 1983), seen on microfiche 38: III. 3–4 at J].

Dianthera paniculata Forssk. (1775).

Dianthera bicalyculata Retz.: 297 (1775 [published in 1776]); Retz.: 10 (1779); Vahl: 6 (1790). *Justicia bicalyculata* (Retz.) Vahl: 13 (1791); Willd.: 81 (1797); Vahl: 113 (1804); Roem. & Schult.: 143 (1817); Roxb.: 127 (1820); Roem. & Schult.: 130 (1822); Wall.: 2457 a–g (1830); Roxb.: 126 (1832). *Peristrophe bicalyculata* (Retz.) Nees: 113 (1832); Nees: 496 (1847); Hook.f. & Benth.: 484 (1849); A.Rich.: 160 (1850); Dalzell & Gibson: 197 (1861); T.Anderson: 47 (1864); T.Anderson: 521 (1867); C.B.Clarke: 554 (1885); Lindau: 331 (1895a); Lindau: 371 (1895b); Lindau: 80 (1897); C.B.Clarke in Burkill & Clarke: 242 & 514 (1899); C.B.Clarke: 85 (1901); Chev.: 501 (1920); Schnell: 20 (1953); Dandy: 28 (1954); Andrews: 185 (1956); Heine: 424 (1963); Cufodontis: 959 (1964); P.G.Mey.: 49 (1968); Agnew: 609 (1974); Solms: 113 & 244

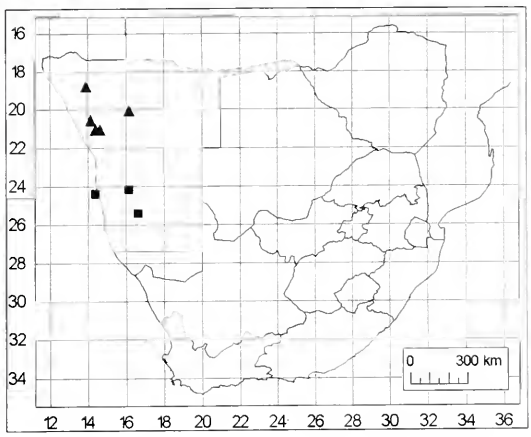

FIGURE 4.—Distribution of *Peristrophe namibiensis* subsp. *namibiensis*, ■; subsp. *brandbergensis*, ▲.

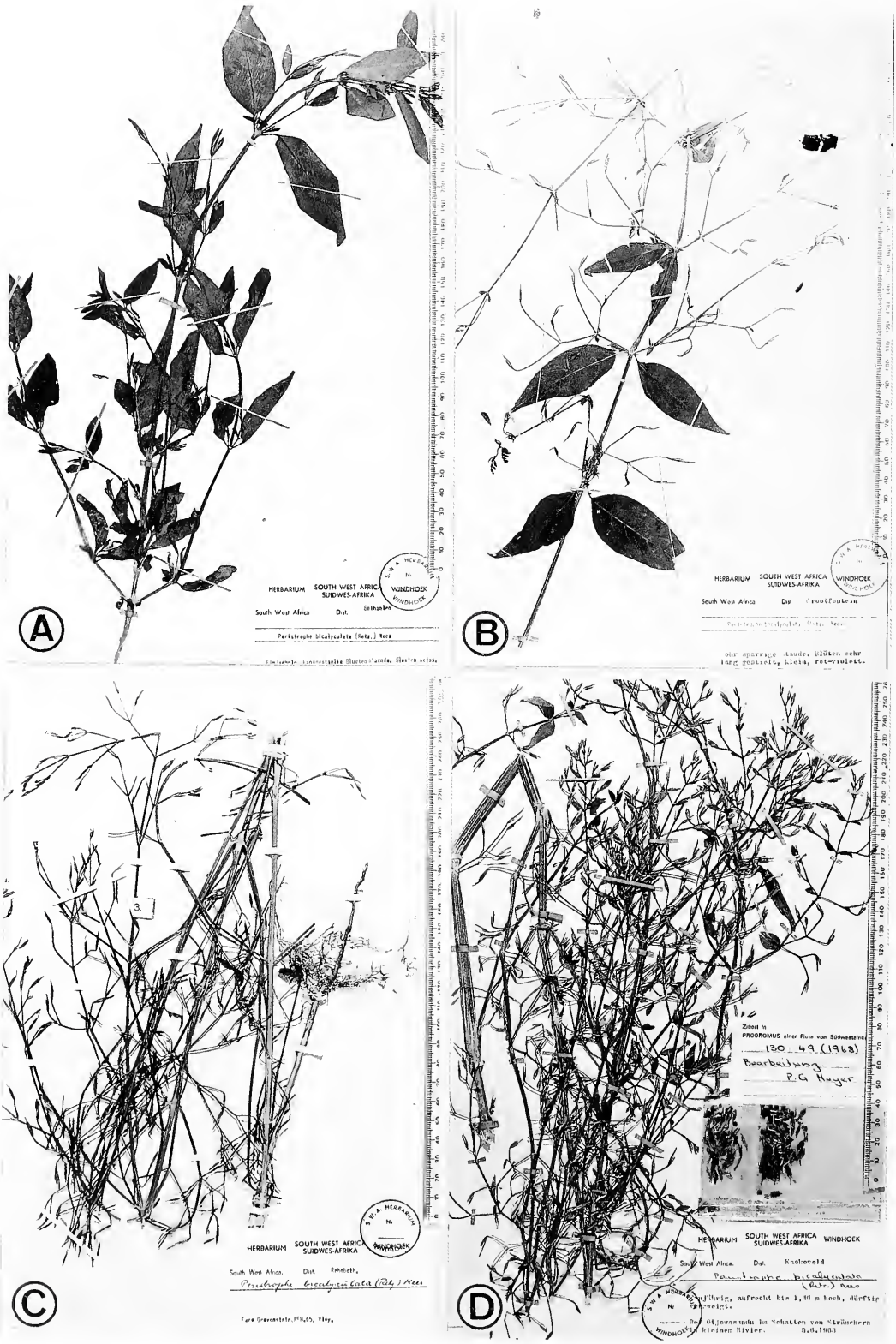

FIGURE 5.—Four specimens of *Peristrophe paniculata*, showing change in habit over one season. A, 26-02-1963, *Giess, Volk & Bleissner 5503* (WIND); B, 25-04-1963, *Giess, Volk & Bleissner 6464* (WIND); C, 09-05-1963, *Leippert 4653* (WIND); D, 05-06-1963, *Giess & Leippert 7317* (WIND). All × 0.35.

(1867). Type: possibly *Koenig* (on microfiche of Linnean herbarium, fide Wood et al. 1983).

Dianthera malabarica L.f.: 85 (1782), nom. illeg. *Justicia malabarica* (L.f.) Aiton: 27 (1789), nom. illeg. Type: as for *D. bicalyculata* Retz.

Justicia ligulata Lam.: 632 (1785); Cav.: 52, t. 71 (1791); Lam.: 40, t. 12, fig. 2 (1791); Lam.: 95 (1811), nom. illeg. Type: as for *Dianthera paniculata* Forssk.

Suffruticose annual up to 2 m high with relatively small tap root system. *Leaves* ovate to lanceolate, acuminate to acute, sometimes rounded, attenuate at base, (12–)17–46 (–65) × 3–14(–38) mm, very thin, slightly scabrid above, soft below, with simple hairs and cystoliths; petiole 0.9–3.9(–36.0) mm. *Inflorescence* of monochasial cymes (inflorescence units), (1)2 or 3(4) umbellately arranged, usually compounded; inflorescence axis (8.0–)11.8–19.4 (–31.0) mm; longest peduncle of inflorescence units (7.0–) 10.9–18.6(–30.0) mm. *Bracts*: secondary bracts lanceolate, (2.5–)3.5–4.6(–7.8) × (0.2–)0.4–0.6(–1.0) mm, with short broad-based eglandular trichomes; tertiary bracts lanceolate, acuminate, larger one (7.0–)9.2–14.9(–18.0) × (0.4–)0.6–1.1(–1.5) mm, sparsely strigose, with short-stalked and sessile glandular trichomes on surface. *Calyx*: tube 1 mm deep; lobes lanceolate, 3 mm long, margins membranous at base, and strigose, with glandular trichomes more common towards base, outer surface sparsely strigose, with sessile glandular trichomes, inner surface sparsely strigose, with appressed eglandular trichomes. *Corolla*: tube (5.0–)5.2–6.6(–7.0) mm deep, with medium, straight and curved eglandular trichomes; lip in lower position elliptic, 3.5–7.2(–7.3) × (1.8–)1.9–2.7(–3.2) mm; lip in upper position narrowly elliptic, (5.0–)5.2–6.9 (–8.0) × (1.2–)1.3–1.7(–1.8) mm; lilac, purple or deep purple. *Stamens*: filaments with short, curved, ornamented eglandular trichomes, white; anther thecae superposed, not touching, purple. *Disc* very shallowly cupular, upper edge crenate with 2 small triangular awns. *Gynoecium*: stigma bilobed; style glabrous; ovary ovoid, very hairy and glandular. *Fruit* (9.0–)9.4–12.3(–14.0) × (2.0–)2.2–2.8(–3.5) mm, hairy. *Seeds* discoid, 2.2–2.4(–2.5) mm, rough and tuberculate.

The names *P. paniculata* and *P. bicalyculata* were both validly published in publications bearing the date 1775. They are taxonomic synonyms but *P. paniculata* has priority (Wood *et al.* 1983). The species has only been collected between February and August, and most often in May in southern Africa. The specimens collected in the earlier months are of younger and smaller plants than those collected in the later months. This is particularly noticeable in the series collected in 1963: *Giess, Volk & Bleissner 5503* (26/02/1963); *Giess, Volk & Bleissner 6464* (25/04/1963); *Leippert 4653* (09/05/1963); *Giess & Leippert 7317* (05/06/1963) (Figure 5). This suggests that the species is an annual, although it has been said to reach 2 m high (fide notes on *Smith 1293* in PRE).

Diagnostic characters: smaller flowers, less than 13.7 mm long, very shallow disc and small simple tap root system serve to separate *P. paniculata* from all other southern African species of *Peristrophe*. It has often been confused with *P. decorticans* and can be separated from the latter species by the mature bark, which is smooth and black in *P. paniculata* and white and peeling in *P. decorticans*; by the ratio of length of larger tertiary bract to that of the shorter, which is (1.4–)1.6–2.2(–2.6) : 1 in *P. paniculata* and 1.2–1.4(–1.6) : 1 in *P. decorticans*; and on the basis of distribution: *P. paniculata* grows in Namibia and in northwestern Botswana; *P. decorticans* in eastern Botswana and in Northern Province. The fruits of *P. paniculata* are more densely sericeous than those of any other species in southern Africa, but the small flowers are the most reliable character with which to distinguish *P. paniculata*. *Distribution*: *P. paniculata* is a widely distributed species and ranges as far east as India, and as far west and south as Namibia (Figure 6). *Habitat*: in southern Africa, it is found in the semi-arid savanna and semidesert areas. *Flowering time*: February to August. *Conservation status*: this widespread species is well represented in many herbaria. The first flowers formed are cleistogamous so that the seed bank is rapidly replenished after seeds germinate. This species is neither rare nor threatened.

5. **Peristrophe transvaalensis** *(C.B.Clarke) K.Balkwill* in Getliffe Norris et al. in South African Journal of Botany 51: 489 (1985). Type: Northern Province, without precise locality, *Holub s.n.* (K, holo.!).

Dicliptera transvaalensis C.B.Clarke: 92 (1901).

Evergreen suffruticose perennial up to 1 m high. *Leaves* ovate to narrowly elliptic, acuminate, attenuate at base, 26–41(–42) × 8–13(–14) mm, with many multicellular eglandular trichomes and cystoliths; petiole (1.7–)2.0–4.3(–4.6) mm. *Inflorescence* of monochasial cymes (inflorescence units), (1 or 2)3(4) umbellately arranged, sometimes compounded; inflorescence axis (4.0–)4.2–7.0(–7.4) mm long; longest peduncle of inflorescence units (2.4–)4.1–12.9 mm long. *Bracts*: secondary bracts 2, free, lanceolate, (4.7–)5.1–6.6 × 0.6–1.0(–1.1) mm, pubescent, sessile; tertiary bracts oblanceolate, unequal, larger one (13.6–)13.8–16.1(–16.4) × (0.4–)0.6–1.1 (–1.5) mm, almost tomentose, trichomes multicellular and eglandular. *Calyx*: tube 1.5 mm deep; lobes, lanceolate, 5.5 mm long, margins membranous and ciliate, with small glandular trichomes on outer surface. *Corolla*: tube (7.3–) 7.5–9.0 mm long, sericeous to tomentose; lip in lower position ovate, (7.1–)8.8(–9.0) × 2.0–2.7 mm; lip in upper position narrowly elliptic, 7.0–8.4(–8.8) × (2.4–)2.5–3.5

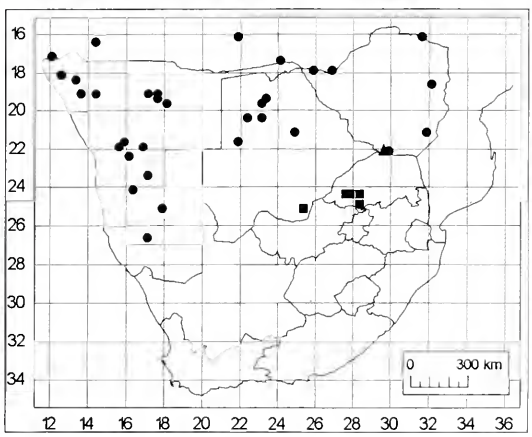

FIGURE 6.—Distribution of *Peristrophe paniculata*, ●; *P. transvaalensis*, ■; *P. cliffordii*, ▲.

(–3.6) mm; light purple with dark purple honey-guides on white background on lip in upper position. *Stamens*: filaments with short and long multicellular eglandular trichomes, white; anther thecae superposed, purple. *Disc* shallowly cupular with crenate top and 2 short stubby awns. *Gynoecium*: stigma shortly bilobed; style sparsely strigose; ovary ovoid, sparsely pubescent. *Fruit* pubescent, 9.0–10.1 × 2.1–2.5 mm. *Seeds* 2.0–2.2 × 1.8–2.0 mm, rough and tuberculate.

It was necessary to transfer *P. transvaalensis* from the genus *Dicliptera* as the placentae are inelastic at the base. *Diagnostic characters*: the closest ally to *P. transvaalensis* is *P. angolensis* which has a characteristic inflorescence structure with many inflorescence units contracted into an axil, and an occasional inflorescence unit with a very long peduncle. In contrast, the inflorescence units of *P. transvaalensis* are not contracted into the leaf axils. The broader tertiary bracts of these two species serve to separate them from the other species of *Peristrophe* in southern Africa. *P. transvaalensis* has a marked vestiture of multicellular uniseriate eglandular trichomes, which imparts a grey-green colour to the leaves of living plants; this feature is very unusual in this section of the genus. *Distribution*: Botswana and southwestern Northern Province (Figure 6). *Habitat*: interface of Acocks's (1988) Sourish Mixed Bushveld and Sour Bushveld [now Mixed Bushveld (Van Rooyen & Bredenkamp 1996a) and Waterberg Moist Mountain Bushveld (Van Rooyen & Bredenkamp 1996b)]. *Flowering time*: in the field the plants were beginning to flower in January, and were flowering profusely when revisited in May, whereas the plants in cultivation were still in flower in August of the same year. It appears that the species flowers throughout the year, but more profusely in winter. *Conservation status*: *P. transvaalensis* is not a common species and is known from only six gatherings from a relatively restricted area and populations of the plant are sparse. The conservation status of this species requires urgent investigation.

6. **Peristrophe cliffordii** *K.Balkwill* in Balkwill et al. in South African Journal of Botany 51: 485 (1985). Type: Northern Province, East [should be west] of Messina, on road to Weipe, 2.8 km from Messina-Pontdrift road, (–BA), *Balkwill 793* (NU, holo.!; PRE!).

Diagnostic characters: *P. cliffordii* can be separated from all other species of *Peristrophe* in southern Africa by its much smaller tertiary bracts (Figure 1F) that are covered in rust-coloured glandular and eglandular hairs. In addition, it, *P. gillilandiorum* and *P. transvaalensis* have many grey hairs between the ridges on the stems (Figure 2E) which separates them from *P. grandibracteata*, which has dense white hairs on its stem, and all other species, which have no or very few hairs between the ridges on the stem. The broader leaves separate this species from *P. gillilandiorum*, and the much smaller tertiary bracts separate it from *P. transvaalensis*. *Distribution*: highly localised near Weipe, west of Messina in the Northern Province (Figure 6). *Habitat*: on Kalahari sands amongst *Colophospermum mopane* in the frost-free Limpopo Valley. *Flowering time*: autumn and winter. *Conservation status*: this species is extremely rare and localised. Repeated droughts coupled with browsing do not augur well for it.

7. **Peristrophe gillilandiorum** *K.Balkwill* in Balkwill et al. in South African Journal of Botany 51: 488 (1985). Type: Northern Province, Dongola, Farm Schroda, (–AB), *Bruce 58* (PRE, holo.!; K!).

Diagnostic characters: the long, narrow leaves of this species are distinctive. For other differences, see under *P. cliffordii*. *Distribution*: very localised in southern Zimbabwe (on Sentinel Ranch) and Northern Province (mainly on the Farm Schroda) (Figure 7). *Habitat*: rocky ridges and on deep clay amongst *Hyphaene coriacea* Gaertn. *Flowering time*: autumn and winter. *Conservation status*: *P. gillilandiorum* is known from only five specimens and is highly localised. One of the habitats (heavy clay) is being ploughed and planted to cotton, making this species both rare and threatened.

8. **Peristrophe decorticans** *K.Balkwill* in Balkwill & Getliffe Norris in South African Journal of Botany 55: 254 (1989). Type: Northern Province, Louis Trichardt Dist., beside N1, at gate to Plaas Marius, north of Wylliespoort, *K.Balkwill 801* (J, holo.!; E!, K!, NU!, PRE!)

P. kotschyana sensu K.Balkwill: 293 (1985); K.Balkwill et al.: 485, 488 (1985); K.Balkwill et al.: 514–520 (1986), non Nees.

Diagnostic characters: *P. decorticans* differs from *P. paniculata*, with which it has often been confused, by its perennial (not annual) habit, woody (not herbaceous) stem bases, white, peeling (not black) bark, strigose (not glandular-pubescent or glabrous) tertiary bracts, larger [14.7–19.0 (not 6.6–13.7) mm long] flowers and usually glabrous (not pubescent) capsule. *P. decorticans* differs from *P. cernua* by its white peeling (not green or white, non-peeling) bark, strigose (not densely glandular) tertiary bracts and presence of honey-guides on the lip in the lower position. *Distribution*: *P. decorticans* occurs in Botswana, North-West, Northern Province and Mpumalanga (Figure 7). *Habitat*: bushveld, usually in the shade of trees. *Flowering time*: plants have been collected in flower throughout the year, with peaks in December, January,

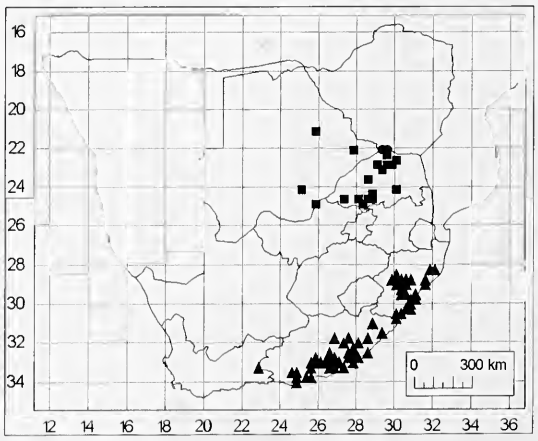

FIGURE 7.—Distribution of *Peristrophe gillilandiorum*, ●; *P. decorticans*, ■; *P. cernua*, ▲.

May, July and November. In cultivation, plants flower sporadically in all seasons, although they produce more flowers in autumn and early winter. *Conservation status*: this species is widespread in southern Africa and is fairly frequent where it occurs; it is neither rare nor threatened.

9. **Peristrophe cernua** *Nees* in Linnaea 15: 374 (1841); Hook.: 126 (1840), nom. nud. as *Peritrophe cernua*; C.B.Clarke: 85 (1901). Type: Eastern Cape, 'Inter frutices ad flumen Zwartkopsrivier, Octobri' [= Inter frutices in campis ad flumen 'Zwartkopsrivier' prope praedium Pauli Mare, alt. I (Uitenhage), cum *Rhytiglossa ciliata*, floret Octobri—in original description], (–CD), *Ecklon Un. It. 556* (GZU, holo.! 2 sheets, STE!).

Peristrophe oblonga Nees: 375 (1841). *Rhinacanthus oblonga* (Nees) Nees: 444 (1847). Type: Eastern Cape, südöstlich vom Katberg, Schumiberg, *Ecklon* (S!).

Justicia caulopsila E.Mey.: 137, 195 (1843), nom. nud.

Peristrophe krebsii C.Presl: 94 (1844); C.B.Clarke: 86 (1901). Type: Eastern Cape, without precise locality, *Krebs pl. cap. exs. n. 251* (BR!).

P. caulopsila E.Mey. ex Nees: 498 (1847); C.Presl: 95 (1844), nom. nud.; T.Anderson: 48 (1864); Lindau: 331 (1895a); C.B.Clarke: 84 (1901). Type: Eastern Cape, Somerset Div., between Zuurberg Range and Kleinbruintjieshoogte, 2000–2500 ft, (–AD), *Drège* (K, lecto.!; G-DC seen on microfiche, here designated).

P. natalensis T.Anderson: 48 (1864); C.B.Clarke 85 (1901); J.H.Ross: 325(1972). Type: KwaZulu-Natal, Port Natal, (–CC), *Gueinzius* (K, lecto.!, here designated).

Non *P. hensii* (Lindau) C.B.Clarke in Burkill & Clarke: 243 (1900); C.B.Clarke: 85 (1901).

Non *P. cernua* sensu Compton: 557 (1976).

Evergreen suffruticose perennial up to 1m high. *Leaves* ovate, acuminate, reniform to cuneate and attenuate at base, (11–)18–37(–50) × (5–)8–16(–23) mm, with multicellular eglandular and short-stalked glandular trichomes; petiole (1.0–)1.2–5.5(–14.6) mm long. *Inflorescence* of monochasial cymes (inflorescence units), (1)2 or 3(4) umbellately arranged, often compounded; inflorescence axis (1.6–)3.3–10.8(–16.0) mm long; longest peduncle of scorpioid cymes (1.7–)4.5–11.6(–22.7). *Bracts*: secondary bracts lanceolate, (2.2–)2.6–4.5(–6.2) × (0.2–)0.3–0.5(–0.6) mm, pubescent; tertiary bracts lanceolate, unequal, larger one (4.7–)6.7–12.0(–16.0) × 1.0–1.3(–1.6) mm, with multicellular eglandular and large and small short-stalked glandular trichomes. *Calyx*: tube 1 mm deep; lobes 3.5 mm long, margins membranous and ciliate, with large and small glandular trichomes. *Corolla*: tube (5.5–)8.0–9.8(–12.0) mm deep, sericeous, with medium-headed glandular trichomes; lip in lower position ovate, (7.2–)9.8–16.5(–22.3) × (2.4–)2.9–5.6 (–8.6) mm; lip in upper position narrowly elliptic, (8.0–)10.0–16.2(–21.3) × (1.6–)2.2–3.4(–4.0) mm; purple with dark purple honey-guides below filaments on lip in lower position, and on white background on lip in upper position. *Stamens*: filaments with short and long, straight and curved, multicellular, eglandular trichomes, white; anther thecae superposed, separated, purple. *Disc* cupular with crenate top and 2 short stubby awns. *Gynoecium*: stigma bilobed; style exserted, sparsely strigose; ovary ovoid, with curved multicellular eglandular trichomes and stalked glandular trichomes. *Fruit* a short-stalked clavate capsule, with glandular and eglandular trichomes, (9.4–)10.4–13.1(–14.0) × (1.5–)1.8–2.3(–3.0) mm. *Seeds* (2.0–)2.2–2.7(–2.9) × (1.5–)1.8–2.2(–2.3) mm, rough and tuberculate.

Diagnostic characters: *P. cernua* is closely allied to *P. decorticans* as discussed under the latter. *P. cernua* can be separated from *P. paniculata* by the larger flowers; from *P. transvaalensis* by the shorter, narrower tertiary bracts (cf. Figure 1E & H), and from *P. cliffordii* and *P. gillilandiorum* by the lack of curved eglandular trichomes between the ridges on the stem (Balkwill *et al.* 1986). *Distribution*: northern KwaZulu-Natal to Eastern Cape (Figure 7). *Habitat*: *P. cernua* is usually found in valley bushveld, and the few specimens that are found out of this veld type are found in coastal forest and thornveld communities. *Flowering time*: plants have been collected in flower throughout the year, but there is a very marked peak in collections in July and August. *Conservation status*: *P. cernua* is widespread and common where it occurs; it is neither rare nor threatened.

Identification of the type of *P. cernua* has been confused by the complexities of Ecklon & Zeyher's collections and numbering system. Zeyher collected and distributed material from the Uitenhage area before initiating a collecting pact with Ecklon (Gunn & Codd 1981). Until then, Ecklon had not collected near Uitenhage and had distributed his specimens through a botanical exchange called Unio Itineraria. Shortly after their pact was initiated, Ecklon collected at Uitenhage and wrote 'A list of plants found in the district of Uitenhage between the months of July 1829 and February 1830', in which *Justicia capensis* is listed under Family 40 (Ecklon 1830). Later he and Zeyher collected in the area together and distributed specimens with either or both their names on the labels and after their pact lapsed, Zeyher collected from there again. Their numbering system was not one with consecutive numbers for consecutive gatherings, but rather the localities were coded in numbers on the labels. Because of the coding system, inconsistencies occurred during the distribution of material so that specimens from the same gathering may have different data on the labels and specimens with the same number, locality and collecting data may be from different gatherings (Gunn & Codd 1981). Some specimens were distributed with personal numbers, some with combined numbers and some with locality numbers. It seems that the number 40 (probably the family number for Acanthaceae) is applied to any sheet they collected of *P. cernua*. Nees (1841) does not cite a herbarium for the type of *P. cernua* (and cites his own herbarium as well as others in 1847). The type was presumably in his own herbarium and distributed to GZU. There are two sheets at GZU that were collected by Ecklon, distributed through the Unio Itineraria and part of a mixed gathering labelled *Justicia capensis*, suggesting that they are part of the type gathering—these sheets are presumably the holotype. A sheet has been found at STE, bearing the number 556 (now crossed out), the name *Justicia capensis*, and an English version of the locality on the sheets at GZU—this sheet is most likely an isotype. One or both of the sheets presently housed at Kew, must represent the gathering(s) to which Hooker (1840) referred when offering Zeyher's material for sale. Hooker's listing of the species antedates Nees's description, but as it was not accompanied by a description, diagnosis or precise locality, it is a *nomen nudum*. It is uncharacteristic of Nees not to quote previous references when they existed, and unlikely that both Nees and Hooker would have inde-

pendently decided on the same name for the same species, so that it appears that Hooker must have seen Nees's manuscript before it was published, or that Ecklon and/or Zeyher may have circulated the specimens with a name which was taken up by Nees. It would, however, have been characteristic of Nees to cite the source of a name, even if he had taken it up from a label. One of the sheets at Kew bears the name *Justicia capensis* and a locality in Ecklon's hand. The sheets at Kew bearing the number 40 are undoubtedly those to which Hooker (1840) referred, most likely those to which Nees referred in 1847, but not those to which he referred in 1841. The Kew sheets also bear the name *Justicia capensis* and this may indicate that these sheets were amongst those to which Ecklon (1830) referred. It is therefore possible that the material at Kew is part of the type gathering (although it has the wrong month on the label). There are two Ecklon & Zeyher specimens and one Zeyher specimen from the type locality at SAM, all with the number 40, but none of these was collected in October and so are not considered part of the type gathering.

The size of the tertiary bracts and flowers of this species displays clinal variation (Balkwill *et al.* 1994). The smaller structures are present in Eastern Cape and the larger in KwaZulu-Natal. It is likely that this cline accounts for a number of the synonyms of *P. cernua*. This species sometimes produces white individuals (*Balkwill 445*) and white populations (*Brink 327*). As the description of *P. krebsii* differs from *P. cernua* mainly by the white corolla, it is possible that this name was applied to a white form of *P. cernua*. Ross (1972) recorded *P. hensii* from KwaZulu-Natal, but this name refers to a tropical species.

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Balkwill 168, 169, 326, 335, 402, 441, 445, 450, 463, 464, 466, 468, 469, 772 (9); 764, 803 (5) E, NU. *Balkwill & Manning 918a* (9) E, NU. *Barker 157, 24068* (9) NBG. *Bayliss 4825* (9) RUH; *7984, BRI. B. 307* (9) PRE. *Benson sub Moss 15705* (9) J. *Biggs M620* (4) PRE. *Blackbeard NBF 869/14* (9) BOL. *Bolus 12219* (5); *1652, 13888, 32311* (9) BOL. *Borle 314* (4) NBG, PRE, SRGH. *Bourquin 144* (9) NU. *Brink 240* (9) GRA; *327, 328* (9) GRA, PRE. *Brown 8801* (4) PRE. *Burchell 3263* (9) K.

Chase 2602 (4) SRGH. *Codd 7549* (4) PRE, SRGH; *9290* (9) GRA, NBG, PRE. *Comins 1561* (9) PRE; *359* (9) NU. *Compton 19744* (9); *326* (4) NBG. *Cooper 161* (9) K; *1618* (9) RUH. *Craven 956* (4) WIND.

Dahlstrand 535 (9) GRA, J. *De Winter & Leistner 5652* (4) PRE, WIND. *Dinter 39, 2909* (4) SAM; *3004* (4) PRE, SAM. *Drummond 6035* (4) PRE; *5560* (4) PRE, SRGH. *Drummond & Seagrief 5177* (4) PRE. *Du Toit 2393* (9) PRE. *Dyer 4374* (9) PRE.

Ecklon & Zeyher 40 (9) BOL, K, SAM. *Edwards 785* (9) NU.

Fanshawe 6829 (4) SRGH. *Fisher 36* (9) NU. *Flanagan 721* (9) BOL, NH, PRE, SAM. *Forward sub GRA A1611* (9) GRA. *Fourcade 2746* (9) BOL, STE; *5755* (9) NBG, STE.

Gajadhur 39 (9) UDW. *Galpin 14806, sub BOL 32312, sub PRE 11553* (9) BOL, PRE; *2044* (9) BOL; *7749, 7805* (9) PRE. *Garrett 20* (9) NU. *Gayapersad 34* (9) UDW. *Germishuizen 775, 811* (5) PRE. *Giess 10377* (4) PRE, WIND; *10480, 15125* (4) WIND. *Giess & Leippert 7317* (4) NBG, WIND. *Giess, Volk & Bleissner 6464* (4) WIND; *5503* (4) PRE, WIND. *Gillett 1293* (9) STE; *3804* (5) STE. *Goldblatt 1929* (4) NBG, PRE, WIND. *Gonde 92/74* (4) PRE, SRGH. *Govender 4* (9) UDW. *Green 188* (9) NH. *Grice s.n.* (9) NU.

Hartley 990 (5) J. *Harvey 3597* (9) BOL. *Huntley 2* (9) NU, PRE. *Hurter sub RUH 3283* (9) RUH.

Jacobsen 4086 (673) (4) PRE; *51* (9) NU.

Keerath 2 (9) UDW. *Khan 13* (9) UDW. *Kunhardt 9* (4) SRGH.

Lambrecht 125 (4) PRE. *Le Roux 1045* (4) WIND. *Leighton sub NBG 48702* (9) NBG P4; *Leippert 4653* (4) WIND. *Lewis 4564, 4565* (9) SAM; *4566* (9) PRE, SAM. *Liebenberg 7754* (9) PRE. *Lindstedt 12* (9) PRE. *Long 685* (9) GRA, MPE, PRE.

Marloth 1312 (4) PRE, STE. *Meeuse 9644* (5) PRE. *Moll 1713* (9) NU, PRE.

Naidoo 11 (9) UDW. *Napper 1254* (4) PRE. *NH 26839* (9) NH. *Nicholson 1760* (9) PRE.

Obermeyer sub Herb. Tvl Mus. 33568 (9) PRE.

Padwa 279 (4) PRE, SRGH. *Paterson 2093* (9) BOL. *Pearson 2550* (4) BOL. *Phelan 636* (9) NU. *Pilland 16571* (9) BOL.

Range 1358 (4) SAM. *Rennie 405* (9) BOL. *Rodin 1069* (9) BOL, PRE. *Rogers 13179* (4) BOL, NH, PRE.

Schlechter 2545 (9) COI, PRE; *2999* (9) COI. *Seydel 1128* (4) PRE. *Sister Frances sub BOL 15707* (9) BOL. *Smith 1293* (4) PRE. *Story 1284, 2227* (9) GRA, PRE.

Taylor 3516 (9) NBG; *491* (9) PRE; *s.n.* (9) GRA. *Thakersee 5* (9) UDW. *Thoday sub Herb. Mus. Austr.-Afr. 25204* (9) SAM. *Thode 2749, sub STE 7964* (9) STE; *A2736* (9) PRE. *Thorne sub Herb. Musei Austr.-Afr. 35709* (4) SAM. *Thornton 644* (4) PRE, SRGH. *Tweedie 3854* (4) SRGH.

Van Breda 866 (9) PRE. *Van Son sub Tvl Museum 28678* (4) PRE. *Van Wyk 1650* (9) PRE, PLI. *Venter 3821* (9) PRE. *Vesey-FitzGerald 1209* (4) SRGH.

Wager sub Tvl Mus. 22382 (9) PRE. *Ward 4974* (9) NU, PRE, UDW; *6925* (9) UDW; *741* (9) NH. *Wells 1340* (9) NU, PRE. *West 1238* (9) PRE. *Wild & Drummond 7129* (4) PRE. *Wood 11881* (9) BOL, SAM; *609* (9) BOL, K.

Zeyher 40 (9) SAM.

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Studies in the Ricciaceae of sub-Saharan Africa: a provisional key to the currently known species

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Keywords: key, *Riccia*, Ricciaceae, sub-Saharan Africa

ABSTRACT

A provisional key to the currently known Ricciaceae species of sub-Saharan Africa is given and is illustrated with micrographs of the distal and proximal spore faces of each species, wherever possible.

INTRODUCTION

For the following reasons I have deemed it advisable to publish a provisional key to the sub-Saharan Ricciaceae, prior to an intended revision of the family of the entire region projected for the not too distant future: 1, it has been brought to my notice several times that such a key would be useful to collectors of the family in tropical Africa; 2, a key to the spores of the southern African species is available (Perold 1989e) but no comprehensive key to the southern African species has been published to date. Such a key was included in my unpublished Ph.D. thesis (Perold 1991d) and it will form part of my treatment of the Marchantiidae for the Cryptogam series of the *Flora of southern Africa* projected for 1997.

In my paper, 'A survey of the Ricciaceae of tropical Africa' (Perold 1995), I deliberately omitted such a key and listed the species alphabetically, as I only intended to report on what was currently known of the family in sub-Saharan Africa, as a preliminary to revising the family in this very undercollected region. In 1994, in an effort to encourage the collection of more *Riccia* specimens, I had submitted requests to all the African delegates present at the AETFAT congress in Wageningen, The Netherlands, asking them to please collect Ricciaceae specimens in their countries and to send duplicates to me, but I have had no response from them, only from a few European collectors who have visited Africa in recent years and to whom I wish to express my sincere gratitude.

Although this key is therefore largely provisional, I hope that it will serve as an identification aid to collectors of African Ricciaceae. Spore micrographs have been included to facilitate the task; unless otherwise stated, all specimens cited in the captions of the figures, are held at PRE.

ARTIFICIAL KEY TO THE GENERA, SUBGENERA, SECTIONS, GROUPS AND SPECIES OF THE RICCIACEAE IN SUB-SAHARAN AFRICA

Key to the two genera of the Ricciaceae

1a Thalli floating or terricolous; assimilation tissue containing large air chambers in several storeys; scales long, pendent, purple ribbons, but small in land form, margins dentate; oil cells present; gametangia located only along deep central groove . . . . . *Ricciocarpos* (only one species is included here, namely *R. natans* (L.) Corda) (Figure 1A, B)

1b Thalli with very rare exceptions terricolous; assimilation tissue spongy, containing air chambers (subgenus *Ricciella*), or else compact, consisting of cell columns enclosing narrow vertical air canals (subgenus *Riccia*); scales small to large, imbricate, mostly rounded, margins smooth, rarely denticulate; oil cells absent; gametangia located along groove or scattered . . . . . *Riccia* (all other species are included here)

Key to the taxa of the genus *Riccia*

1a Thalli covered by a dorsal epidermis of mostly thin-walled, generally chlorophyllose cells, very rarely dorsally bearing cellular outgrowths; air pores fewer in number than in subgenus *Riccia*, mostly delimited, often ringed by smaller cells, well spaced, frequently becoming cavernous; assimilation tissue loosely arranged, spongy, unistratose cell plates enclosing large polyhedral air chambers; ventral scales small and evanescent to occasionally large and persistent, in 1 or 2 ranks when present; habitat mostly mesic, rarely xeric or aquatic; spores separating at maturity or remaining in tetrads: (1b on p. 97)

2a Dorsal epidermis a single layer of thin-walled, closely joined, flattened cells (very rarely globose, and then somewhat loosely connected), interrupted by air pores, becoming cavernous over air chambers or not; scales ventral, mostly hyaline and inconspicuous, evanescent: (2b on p. 97)

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3a Thalli annual or perennial; sometimes in rosettes; always terrestrial; branches not strap-shaped, 2–15 × (1–)3–6(–8) mm; often becoming slightly to markedly cavernous; monoicous or dioicous; sporangia deeply imbedded or bulging somewhat dorsally or ventrally:
4a Spores separating at maturity:
5a Thalli moderately thick and ± opaque, not translucent; branches 2–8 times wider than thick; storage tissue up to ± ½ the thickness of thallus; spores (50)65–150(–160) µm in diam., polar, tetrahedral, winged, ornamentation reticulate, rarely with vermiculate ridges (subgenus *Ricciella*):
6a Thalli not inflated but finely to coarsely spongiose; dorsally not deeply grooved or rarely only apically so; often in complete or partial rosettes; glaucous green to yellow green, sometimes tinged with red or purple (section *Spongodes*, group 'Crystallina'):
7a Thalli monoicous; from above air chamber walls visible or not; spores completely or incompletely reticulate:
8a Thalli blue-green; in complete or partial rosettes; from above air chamber walls not clearly visible; without or with tiny hyaline ventral scales; spores 52–85 µm in diam., light brown, ornamentation on proximal and distal faces similar:
9a Thalli dorsally crystalline and glistening, with rounded cells in loose double tiers, usually obscuring air pores when fresh, with age becoming spongiose; scales absent or evanescent; ornamentation on 2 spore faces similar, areolae regular and complete, on distal face 8–10 across, 7.5–10.0 µm wide, walls thin and much higher at nodes, often with bifid or trifid processes, triradiate mark on proximal face distinct, each facet with up to 20 areolae, 5.0–7.5 µm wide . . . . . *R. crystallina* (Figure 1C, D)
9b Thalli dorsally vesicular-areolate, air pores not obscured, soon spongiose; ventral scales tiny; ornamentation on 2 spore faces similar, areolae regular and mostly complete on both faces, distal face with only 5 or 6 areolae across, 12.5–17.5 µm wide, proximal face with up to 13 areolae on each facet, walls with crenulate edges, mostly not higher at the nodes and lacking bifid processes . . . . . *R. vulcanicola* (Figure 1E, F)
8b Thalli yellow-green or blue-green, sometimes developing red or purple-red coloration; in rosettes or in gregarious patches; from above air chamber walls visible, air chambers large or small; small, purple, ventral scales sometimes present; spores 65–115 µm in diam., red-brown to black or light brown, ornamentation on distal and proximal faces dissimilar:
10a Thalli green to yellow-green, faintly tinged with red at margins; in rosettes; from above walls of large air chambers visible or air chambers cavernous; scales absent; spores 85–115 µm in diam., red-brown to black, distal face with thicker, irregularly bi- or trichotomously branching ridges, proximal face with triradiate mark distinct, areolae incomplete . . . . . *R. cavernosa* (Figure 2A, B)
10b Thalli blue-green; in gregarious patches; from above finely areolate; scales present, purple or hyaline; spores 65–85 µm in diam., light brown, distal face with 8–10 areolae across, proximal face with triradiate mark absent but with numerous tiny, shallow areolae . . . . . *R. moenkemeyeri* (Figure 2C, D)
7b Thalli dioicous; heterothallic with smaller male plants; bright green to yellowish green or grey-green; in rosettes; from above air chamber walls visible, becoming cavernous or hardly so; spore ornamentation foveolate or vermiculate (section *Spongodes*, group 'Cupuliferae'):
11a Thalli bright green; in medium-sized rosettes; cavernous with age; dorsal pores fairly conspicuous, soon enlarging with age; spores 95–122 µm in diam., ornamentation foveolate, with small, deep-set areolae, triradiate mark on proximal face very prominent; distribution restricted to southern Africa . . . . . *R. cupulifera* (Figure 2E, F)
11b Thalli grey-green, slightly purple at margins; in small rosettes; dorsal pores slightly enlarging with age; spores 40–65 µm in diam., ornamentation with ± radiating vermiculate ridges on both faces, triradiate mark distinct; widely distributed in tropical and northern Africa, Europe and N America, especially at alluvial sites . . . . . *R. frostii* (Figure 3A, B)
6b Thalli inflated to rather flat; usually becoming markedly cavernous; dorsally grooved along entire length or only apically; rarely in rosettes; green to straw-coloured or whitish, very rarely tinged with purple or red (section *Spongodes*, group 'Vesiculosa'):
12a Thalli large and very wide, 5.0–15.0 × 3.5–5.5(–8.0) mm; when dry, yellowish to straw-coloured or white; spores 100–150 (–160) µm in diam., with 8–12 areolae across distal face, wing 10 µm wide and thin:
13a Thalli straw-coloured when dry; deeply grooved along entire length; cavernous in older parts only; spores with areolae on distal face 10–15 µm wide . . . . . *R. bullosa* (Figure 3C, D)
13b Thalli white when dry; mostly only apically grooved; honeycomb-pitted dorsally; spores with areolae on both faces mostly wider than 10–15 µm, often up to 20 µm . . . . . *R. garsidei* (Figure 3E, F)
12b Thalli medium-sized and narrower, up to 12 × 2.5–3.0 mm; when dry, greyish white to yellowish; spores 88–112 µm in diam., with 5–8 areolae across distal face, wing not thin but 3–5 µm wide:
14a Thalli occasionally in rosettes; branches broadly ligulate to lingulate; antheridial necks inconspicuous, hyaline; widespread in summer rainfall areas of southern Africa . . . . . *R. volkii* (Figure 4A, B)
14b Thalli never in rosettes; branches somewhat linear; antheridia with conspicuous purple necks; very rare, only known from Knysna Dist. in the Western Cape . . . . . *R. rubricollis* (Figure 4C, D)
5b Thalli very thin and ± translucent; branches 10–15 times wider than thick; storage tissue vestigial; spores 40–65 µm in diam., apolar, globose, wingless, ornamentation with numerous small, low truncate spines or papillae (subgenus *Leptoriccia*) . . . . . *R. membranacea* (Figure 5E, F)
4b Spores remaining in tetrads (subgenus *Thallocarpus* with two species):
15a Thalli in complete or incomplete rosettes, 10–20 mm across; heterothallic, male plants once or twice furcate, very rarely in incomplete rosettes; branches small, 2.0 × 0.5 mm, occasionally larger; spores joined together by narrow band or ridge into tetrahedral tetrads, ornamentation with slender spinules up to 5 µm long . . . . . *R. curtisii* (Figure 6A, B)
15b Thalli reportedly in rosettes up to 11 mm across; male plants small; spores joined together by wide band into rhomboidal tetrads, ornamentation with stout spines, 10–15 µm long . . . . . *R. perssonii* (Figure 6C, D)
3b Thalli generally annual; mostly not in rosettes; terrestrial or occasionally aquatic; branches usually linear, strap-shaped or 'ribbon-like', 15–20 mm long and up to 2 mm wide, occasionally smaller; dorsally often tinged with violet, seldom lacunose; at times forming apical stolons; sporangia ventrally bulging markedly (section *Ricciella*):
16a Thalli monoicous:
17a Thalli sometimes aquatic; strap-shaped or ribbon-like; widespread in mostly summer rainfall areas of southern Africa and in tropical Africa; scales few, ventral, proximally split into 2, apically single; sporangia oblique; distal spore face with areolar walls thick and prominent, proximal spore face with distinct triradiate mark . . . . . *R. stricta* (Figure 4E, F)
17b Thalli terrestrial; in small rosettes; branches narrow; ventral scales vestigial; dorsally somewhat lacunose proximally; sporangia vertical; spores with complete, regular areolae on both faces, proximal face lacking triradiate mark; rare in tropical Africa, mostly in Europe and N America . . . . . *R. huebeneriana** (Figure 5A, B)
16b Thalli dioicous; terrestrial; linear, thin and lax; distribution restricted to winter rainfall area of the Western Cape; sporangia vertical; distal spore face with areolar walls thin, proximal face with distinct triradiate mark . . . . . *R. purpurascens* (Figure 5C, D)

* Perold (1995) misplaced *R. huebeneriana* in her classification of African Ricciaceae, as she referred it to section *Spongodes*, group 'Crystallina'. It should be placed in section *Ricciella* on account of its ventrally protruding sporangia.

2b Dorsal epidermis not with thin-walled, single-layered flat cells interrupted by air pores:
18a Dorsal epidermis devoid of cellular outgrowths, but with thick-walled cells, lacking chlorophyll; air pores surrounded by superimposed ring of smaller, thin-walled cells; thallus narrowly grooved, acutely winged; scales rounded, persistent, large, reaching thallus margins; spores single (subgenus *Chartacea*) . . . . . *R. schelpei* (Figure 6E, F)
18b Dorsal epidermis with cellular outgrowths of very tall, hair-like pillars; air pores surrounded by radially arranged wedge-shaped cells; thallus broadly grooved, obtusely winged; scales triangular, persistent, large, filamentous apices extending above thallus margins; spores remaining in globular to tetrahedral tetrads (subgenus *Pannosae*) . . . . . *R. tomentosa* (Figure 7A, B)
1b Thalli covered by a dorsal 'epithelium' of echlorophyllose cells in one or several strata; air pores numerous, small and regular intercellular spaces; assimilation tissue compact, in vertical rows of chlorophyllose cells separated by mostly very narrow interstitial air canals; ventral scales small to large; habitat often xeric, sometimes mesic; spores separating at maturity (subgenus *Riccia*):
19a Epithelial cells closely associated, in one or two layers, generally orientated regularly and in parallel rows running from median groove to margin; top cells globose, mammillose or pyriform, outer walls (or cells) often collapsing; scales small to large, rounded (section *Riccia*): (19b on p. 99)
20a Thalli with cilia along margins, occasionally also present over sporangia; ventral scales mostly not conspicuous; sometimes flanks dark purple (group 'Ciliatae'):
21a Thalli shortly or distinctly winged laterally; medium-sized to large, 7.0–30.0 × 2.5–10.0 mm; cilia short or long; spores straw-coloured or reddish brown:
22a Thalli shortly winged, medium-sized; branches 10–12 × 4 mm; cilia tapering, white when dry, up to 300(–400) × 30–50 µm at base, finely granular, absent over sporangia; spores straw-coloured, (95–)110–115 µm in diam., with wing 10 µm wide, slightly undulating; distribution restricted to southern Africa; hygrophyte . . . . . *R. natalensis* (Figure 7C, D)
22b Thalli distinctly winged, large; branches 7–30 × 2.5–10.0 mm; cilia 100–325 × 75–150 µm at base, hyaline and shiny; spores reddish brown, (130–)170–180(–215) µm in diam., with wing 9–10(–15) µm wide; widely distributed in the northern hemisphere . . . . . *R. gougetiana* (Figure 7E, F)
21b Thalli not winged laterally, smaller, less than 8.0 × 1.5 mm; cilia hyaline, dry or wet, long or short; spores brown to black, with or without wing; distribution widespread:
23a Distribution in southern Africa restricted to winter rainfall region of the Western Cape; hygrophyte; branches 3–6 × 1 mm; cilia generally quite sparse, 250(–400) µm long, finely granular, absent over sporangia; scales small, purple; flanks green; spores with wing ± 7.5 µm wide . . . . . *R. crozalsii* (Figure 8A, B)
23b Widespread in summer rainfall areas; xerophytes; cilia crowded, dense, variously long, not granular, present over sporangia; flanks dark purple; spores mostly wingless:
24a Thalli 5.0–6.0 × 0.9–1.5 mm; cilia straight to slightly flexuose, up to 950 µm long, smooth; spores 100–120 µm in diam., ornamentation reticulate, areolar walls heavily encrusted with papillae . . . . . *R. trichocarpa* (Figure 8C, D)
24b Thalli small, 1.0–4.0 × 0.6–0.8 mm; cilia arched, up to 300 µm long, channelled and finely striate; spores 80–90 µm in diam., ornamentation reticulate, areolar walls mostly smooth . . . . . *R. microciliata* (Figure 8E, F)
20b Thallus margins not ciliate, marginal cells enlarged or not; ventral scales small to large:
25a Thalli medium-sized; margins apically with row of mammillate cells up to 150 µm long; scales small, not extending to thallus margins, violet to hyaline; very rare (group 'Mammillatae') . . . . . *R. mammifera* (Figure 9A, B)
25b Thalli small to large; margins glabrous; scales larger, extending to margins or projecting above, hyaline or variously pigmented:
26a Scales not conspicuous, hyaline or partly hyaline; thallus margins hyaline; groove narrow and deep, persistent along most or whole length of thallus; dorsal epithelium sometimes with some cell walls thickened (group 'Squamatae'):
27a Dorsal epithelial and subepithelial cells always with markedly thicker walls; thalli light green, appearing almost waxy; margins not undulate; flanks green; spores polar, dark reddish brown to black, proximal face densely granulate; distribution widespread (nearly cosmopolitan) but apparently quite rare in tropical Africa . . . . . *R. sorocarpa* (Figure 9C, D)
27b Dorsal epithelial cells with walls rarely thicker; thalli glaucous green to bright green; margins undulate; flanks dark red-brown or violet; spores almost apolar or polar, dull dark brown to nearly black, reticulate:
28a Thalli large; apices rounded; margins usually strongly and irregularly undulate, overhanging in cross section; spores 110–125 µm in diam., triangular-globular, polar, not winged, uniformly reticulate on both faces, ± 7 areolae across distal face, 15–20 µm wide, triradiate mark on proximal face indistinct; plants rare . . . . . *R. nigerica* (Figure 9E, F)
28b Thalli medium-sized or smallish; apices tapering to obtusely rounded; margins not strongly undulate, not overhanging in cross section, but flanks rising ± steeply, to slightly obliquely; spores smaller, 75–105 µm in diam.:
29a Thallus flanks not appearing vertically 'striped'; spores almost apolar, subglobular, wingless, proximal face without triradiate mark, ornamentation on 2 faces similar, distal face with 10–12(–14) areolae across, 7.5–12.5 µm wide . . . . . *R. atropurpurea* (Figure 10A, B)
29b Thallus flanks often appearing vertically 'striped' due to hyaline margins of scales above purple bases; spores polar, triangular-globular, winged, proximal face with triradiate mark distinct:
30a Thalli medium-sized; branches up to 2.5 mm wide; spores with 2 faces dissimilar, facets on proximal face almost smooth or with poorly developed areolar walls, distal face with (5)6–8 areolae across the diam., (10–)12–22 µm wide, but areolae often incomplete, areolar walls up to 5 µm high . . . . . *R. lanceolata* (Figure 10C, D)
30b Thalli smallish; branches 1.0–1.5 mm wide; repeatedly furcate; spores with 2 faces similar or dissimilar:
31a Spores with 2 faces similar, distal face with 8 or 9 areolae across the diam., 13–15 µm wide, areolar walls sometimes ± incomplete, rather thick and raised at nodes into sharply truncate, plate-like papillae, 3–5 µm high . . . . . *R. radicosa* (Figure 10E, F)
31b Spores with 2 faces dissimilar, distal face with central areolae ± 10 µm wide, decreasing in size toward margins, proximal face with numerous small areolae, ± 2.5 µm wide, on each facet . . . . . *R. schweinfurthii* (Figure 11A, B)
26b Scales often large and conspicuous, pigmented, with or without hyaline border or entirely hyaline to white; groove various; dorsal epithelial cell walls not thickened:
32a Scales dark, black or reddish black to deep violet, shiny; thallus size variable; dorsally glaucous green to green or purplish, rarely brown:
33a Thalli medium-sized to large; in section 2.5–5.0 times wider than thick; flanks sloping obliquely:
34a Thalli large, up to 15 × 5 mm; margins winged, overhanging; spores subglobular, apolar, ornamentation reticulate with thin, high areolar walls . . . . . *R. congoana* (Figure 11C, D)
34b Thalli medium-sized to large, up to 15 × 2(–4) mm; margins attenuate, not overhanging; spores triangular-globular, polar, areolar walls thick, low:
35a Distribution restricted to winter rainfall regions of Western and Northern Cape; thalli quite fleshy; scales imbricate, clasped together along midline when dry; spores 90–125 µm in diam., distal face with short spiralling ridges, proximal face almost smooth, with scattered pores . . . . . *R. limbata* (Figure 11E, F)
35b Distribution widespread in summer rainfall regions, but not common; thalli mostly thinner; scales imbricate to proximally more widely spaced; when dry, opposite scales meeting or not, never clasped together; spores 72–82 µm in diam., distal face with areolae in more or less concentric rings, proximal face completely or incompletely reticulate . . . . . *R. angolensis* (Figure 12A, B)

33b Thalli smallish to medium-sized; in section 1–2 times wider than thick; flanks steeply rising:
36a Thalli medium-sized; bluish green; scales projecting above thallus margins, edge crenate, rather dull black, dry; spores golden brown, wingless, densely papillate . . . . . *R. okahandjana* (Figure 12C, D)
36b Thalli smallish; glaucous green, rust-brown along margins and proximally; scales appressed, not projecting above thallus margins, edge smooth, shiny dry or wet; spores light brown to dark brown, winged, incompletely reticulate . . . . . *R. nigrella* (Figure 12E, F)
32b Scales other than black, variously coloured or white; thalli small to medium-sized; dorsally green to yellow-green, white or brownish:
37a Scales brown or various shades of red, pink or violet:
38a Thallus margins and scales brownish yellow; idioblasts (enlarged cells with brown contents) present throughout thallus; spores vermiculate; species very rare in sub-Saharan Africa . . . . . *R. macrocarpa* (Figure 13A, B)
38b Thallus margins not brown; scales dark red or pink or violet; idioblasts absent; spores reticulate:
39a Thalli very small, 1.5–2.5(–3.0) × 0.7–1.0 mm; bottle-green, turnid; scales regular, appressed, dark red, white-bordered; spores 60–78 µm in diam., triangular-globular, polar; distribution restricted to Free State and Eastern Cape . . . . . *R. pottsiana* (Figure 13C, D)
39b Thalli medium-sized to robust; bright green or light green to whitish, sometimes tinged with red or violet; scales purple-red, wine-red or cherry-red to rose-pink, exceptionally not persistent; spores 75–125(–140) µm in diam., mostly globular to subglobular, apolar, rarely triangular-globular and polar; widespread or rare:
40a Thalli with assimilation tissue containing somewhat wider than usual air canals toward margins; if in rosettes these are irregular; thallus margins parallel or subparallel; spores always apolar:
41a Thalli robust, up to 12 mm long; not in rosettes; scales smallish, pink-red to violet, distant; perennating by apical stolons; spores globular, apolar, 90–110–(135) µm in diam., areolae 12–15(–18) µm wide, lacking spines at nodes . . . . . *R. discolor* (Figure 13E, F)
41b Thalli smallish, up to 5 mm long; in irregular rosettes; scales not persistent; not perennating by stolons; spores globular, apolar, 80–90(–95) µm in diam., areolae 12–15 µm wide, at nodes truncate spines 4–8 µm high . . . . . *R. symoensii* (Figure 14A, B)
40b Thalli with assimilation tissue containing narrow air canals throughout; rarely in incomplete rosettes; thallus margins generally tapering toward apex; spores mostly apolar, only exceptionally polar:
42a Thalli up to 8.5 × 1.5–2.0 mm, light green; scales purplish red to deep cherry-red, lacking hyaline border and only slightly projecting above thallus margins, imbricate; spores triangular-globular, polar, both faces ornamented with tiny areolae . . . . . *R. erubescens* (Figure 14C, D)
42b Thalli 6–12 × 1–4 mm; green, turning grey-green, or not, or pale green and white along margins or light bluish green, becoming violet or brownish grey with age; scales dark red or rose-pink or purple, with or without hyaline border; spores apolar:
43a Thalli 7.0–12.0 × 1.0–2.5 mm; bright green, turning grey-green or pale green and white along margins; scales dark red or rose-pink, with narrow or wide hyaline border:
44a Thalli 7.0–9.0 × 1.2–1.6 mm; bright green, turning grey-green; scales dark red, shiny, with narrow hyaline border; monoicous; spores ruby-red to black, (80–)85–105 (–110) µm in diam., subglobular, (6–)8–10 areolae across spore face, 10.0–12.5 µm wide, periphery with prominent projections, up to 7.5 µm long, appearing cogwheel-like in profile . . . . . **R. runssorensis* (Figure 14E, F)
44b Thalli up to 12.0 × 1.0–2.5 mm; pale green, along margins white; scales wavy, rose-pink with wide hyaline border; dioicous; spores rare, light brown, periphery with low projections . . . . . *R. rosea* (Figure 15A, B)
43b Thalli 6–12 × 2–4 mm; light bluish green, turning violet to brownish grey with age, or green; scales purple-red or dark red to purple, without hyaline border:
45a Thalli up to 12 × 2–4 mm; light bluish green, becoming violet to brownish grey with age; in section 2–2½ times wider than thick; scales purple-red, projecting slightly beyond thallus margins; spores 70–80 µm in diam., dark red, margin with numerous low, blunt projections . . . . . *R. saharensis* (Figure 23C, D)
45b Thalli 6–7 × 2–3 mm; green; in section up to 7 times wider than thick; scales dark red to purple, shiny, inserted beneath thallus wings and projecting slightly beyond margins; spores 92.5–105.0 µm in diam., dark red to almost black, marginal papillae ± 5 µm high . . . . . *R. papillispora* (Figure 23E, F)
37b Scales predominantly hyaline or white, wavy or appressed; thalli without or with calcium deposits:
46a Thalli and scales lacking calcium deposits:
47a Thalli up to 7.0 × 1.3–1.8 mm, white-green to blue-green; dioicous; antheridial necks conspicuous, up to 250 µm long; spores deep red-brown, wingless, (105–)115–125 µm in diam., with 11 areolae across distal face; very rare species . . . . . *R. somaliensis* (Figure 15C, D)
47b Thalli 5–15 × 2–4 mm, light grey-green; monoicous; antheridial necks inconspicuous, 60–85 µm long; spores dark brown, narrowly winged or wingless, (75–)90–120(–125) µm in diam., with up to 10 areolae across distal face; widespread species . . . . . *R. lamellosa* (Figure 15E, F)
46b Thalli and scales with calcium deposits:
48a Scales large, 850–1250 × 500–750 µm, irregularly wavy to frilly, closely imbricate; thalli mostly 8.0–9.0(–12.0) × 1.5–2.0 (–4.0) mm; apically grooved; dorsally green, turning white and spongy over sporangia:
49a Thalli in rosettes or gregarious; widespread and quite common; spores with 10–12 round to angular areolae across diam. of distal face . . . . . *R. albolimbata* (Figure 16A, B)
49b Thalli not in rosettes; spores with 14–20 small deep areolae across diam. of distal face; quite rare, distribution apparently restricted to Northern Cape . . . . . *R. albornata* (Figure 16C, D)
48b Scales rather smaller, up to 850 × 500 µm, mostly appressed and regular, imbricate; thalli generally slightly smaller, 7.0–8.0(–12.0) × 0.7–2.0(–4.0) mm; apically grooved or along almost the entire length; dorsally dull or shiny:
50a Thalli deeply grooved along most of entire length; dioicous; spores apolar or polar:
51a Thalli dorsally dull grey-green, compact; dorsal epithelial cells often rather thick-walled; air pores triangular or quadrangular; scales regular, appressed, base purple-grey; spores apolar, wingless; fairly widespread . . . . . *R. argenteolimbata* (Figure 16E, F)
51b Thalli dorsally glistening, light green to green; finely spongy; dorsal epithelial cells thin-walled, not in regular pattern; scales apically wavy, soon appressed; spores polar, winged; distribution restricted to eastern mountainous regions of southern Africa . . . . . *R. montana* (Figure 17A, B)

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* In Jones's (1957) opinion, *R. runssorensis* Steph. and *R. papillispora* Steph. are closely allied plants and judging from the portions of the types that he had seen, they may be identical. I, however, regard them as different species, the scales of *R. papillispora* lack a hyaline border and its spores have shorter papillae, as noted by Jones.

50b Thalli only apically grooved; monoicous; spores polar:
52a Thalli with wide, shallow groove, 8 × 4 mm, dorsally very heavily encrusted with calcium deposits; air pores large, regular; scales white; spores finely reticulate . . . . . *R. alboporosa* (Figure 17C, D)
52b Thalli narrowly grooved, up to 5 × 1–2 mm, dorsally with fine calcium deposits; air pores small to large, irregular; scales bicoloured, with deep purple base; spores more coarsely reticulate . . . . . *R. bicolorata* (Figure 17E, F)
19b Epithelial cells in free-standing 2–5(6)-celled, uniseriate pillars, irregularly orientated; top cells variously shaped, soon collapsing; scales small to large, mostly rounded and smooth-margined, rarely triangular and dentate or apically filiform (section *Pilifer*):
53a Dorsal pillars short, often less than 200 µm long, consisting of 2 or 3(4) cells, mostly wider than long, tapering or not tapering:
54a Dorsal pillars tapering; air canals up to 100 µm wide:
55a Spores wide-winged, wing up to 10 µm wide, elaborately ornamented; very rarely found:
56a Thalli large, up to 10.0 × 2.5–3.8 mm; scales hyaline . . . . . *R. hantamensis* (Figure 18A, B)
56b Thalli small, up to 5.0 × 0.9–1.5(–2.0) mm; scales red . . . . . *R. alatospora* (Figure 18C, D)
55b Spores narrow-winged, wing up to 5 µm wide; ornamentation less elaborate, especially on proximal face, where often reduced to simple projections and stipplings; widespread . . . . . *R. albovestita* (Figure 18E, F)
54b Dorsal pillars not tapering; air canals narrow:
57a Thalli quite large, up to 10 × 3–4 mm; broadly ovate to obovate; in section 3–4 times wider than thick; flanks sloping obliquely; distal spore face with 10–14 areolae across diam., sometimes with central papilla or short radiating ridges . . . . . *R. concava* (Figure 19A, B)
57b Thalli smaller, up to 8 × 1–2 mm; ligulate to ovate; in section as wide as, to twice wider than thick; flanks steep; spores variously ornamented:
58a Branches frequently simple, long and narrow; spore distal face with 5–7 large, incomplete areolae across diam., often with central boss . . . . . *R. elongata* (Figure 19C, D)
58b Branches mostly several times furcate; spore distal face with more than 7 smaller areolae across diam., lacking central boss:
59a Branches apically keeled to wedge-shaped; margins somewhat tumid; dorsal cell pillars up to 180 µm long; proximal spore face reticulate:
60a Dorsal pillars with top cell mammillose; distal spore face with ridges generally forming a central cross; distribution restricted to Western and Northern Cape . . . . . *R. furfuracea* (Figure 19E, F)
60b Dorsal pillars with top cell globose; distal spore face with ± 8 angular, irregular areolae across diam.; distribution apparently restricted to Lesotho . . . . . *R. trachyglossum* (Figure 20A, B)
59b Branches apically rounded; margins not tumid; dorsal cell pillars only 70–105 µm long; proximal spore face granulate . . . . . *R. pulveracea* (Figure 20C, D)
53b Dorsal pillars tall, longer than 200 µm and up to ± 450 µm (rarely 1000 µm) long, consisting of (3)4–6 narrow, elongated cells, (1½–)2–3 (or more) times longer than wide:
61a Dorsal surface of thallus generally somewhat velvety or furry when fresh; emerald-green to lighter green; pillars gradually tapering to narrower apical cell:
62a Scales rounded, wavy, large, 1500 × 600–900 µm, margin smooth; thallus emerald-green; basal cells of pillars almost equally long, walls somewhat thickened; spores polar, ornamentation finely or coarsely reticulate . . . . . *R. simii* (Figure 20E, F)
62b Scales triangular, very large, up to 1800 µm long; basal cells of pillars variably long, walls not thickened; spores variously ornamented:
63a Triangular scales with dentate margins; dorsal pillars up to 450 µm long; spores papillose; not rare, but distribution restricted to the Northern and Western Cape . . . . . *R. villosa* (Figure 21A, B)
63b Triangular scales with filamentous apices; dorsal pillars up to 1000 µm long; spore ornamentation incompletely reticulate; very rare . . . . . *R. hirsuta* (Figure 21C, D)
61b Dorsal surface of thallus rarely velvety or furry; steel-grey to bright green or olivaceous green; cell pillars not, or hardly tapering:
64a Dorsally steel-grey; dorsal pillars tall (up to 450 µm long), like slivers of glass, often interlocking over groove; thalli larger, up to 9 mm long; scales large and billowing, basal cell walls appearing 'stretched'; proximal spore face incompletely reticulate and granulate, distal face with a few short, well-spaced, radiating, central ridges . . . . . *R. vitrea* (Figure 21E, F)
64b Dorsally olivaceous green or crystalline; dorsal pillars shorter (mostly less than 350 µm long), not interlocking, or if so, only temporarily toward apex; thalli mostly less than 8 mm long; scales smaller and not billowing; spore ornamentation completely reticulate on proximal face, not granulate, distal face reticulate or with several, long, thick, radiating ridges:
65a Dried thalli with brown, parchment-like flanks, proximally almost without scales; wet thalli velvety, olivaceous green; distal spore face with thick radiating ridges . . . . . *R. albomarginata* (Figure 22A, B)
65b Dried thalli frequently with somewhat purple flanks; wet thalli rather crystalline, bright green or purplish green:
66a Thalli in section 1.5 times to nearly twice wider than thick; sides tightly inflexed when dry . . . . *R. namaquensis* (Figure 22C, D)
66b Thalli in section 2–4 times wider than thick; sides incurved when dry:
67a Cells in dorsal pillars mostly somewhat constricted in middle, ampulla-shaped; spores 90–95(–105) µm in diam., distal face with several radiating ridges; distribution restricted to eastern mountains in southern Africa . . . . . *R. ampullacea* (Figure 22E, F)
67b Cells in dorsal pillars not constricted; spores 70–80(–90) µm in diam., ornamentation with numerous small areolae; distribution restricted to Western Cape . . . . . *R. parvo-areolata* (Figure 23A, B)

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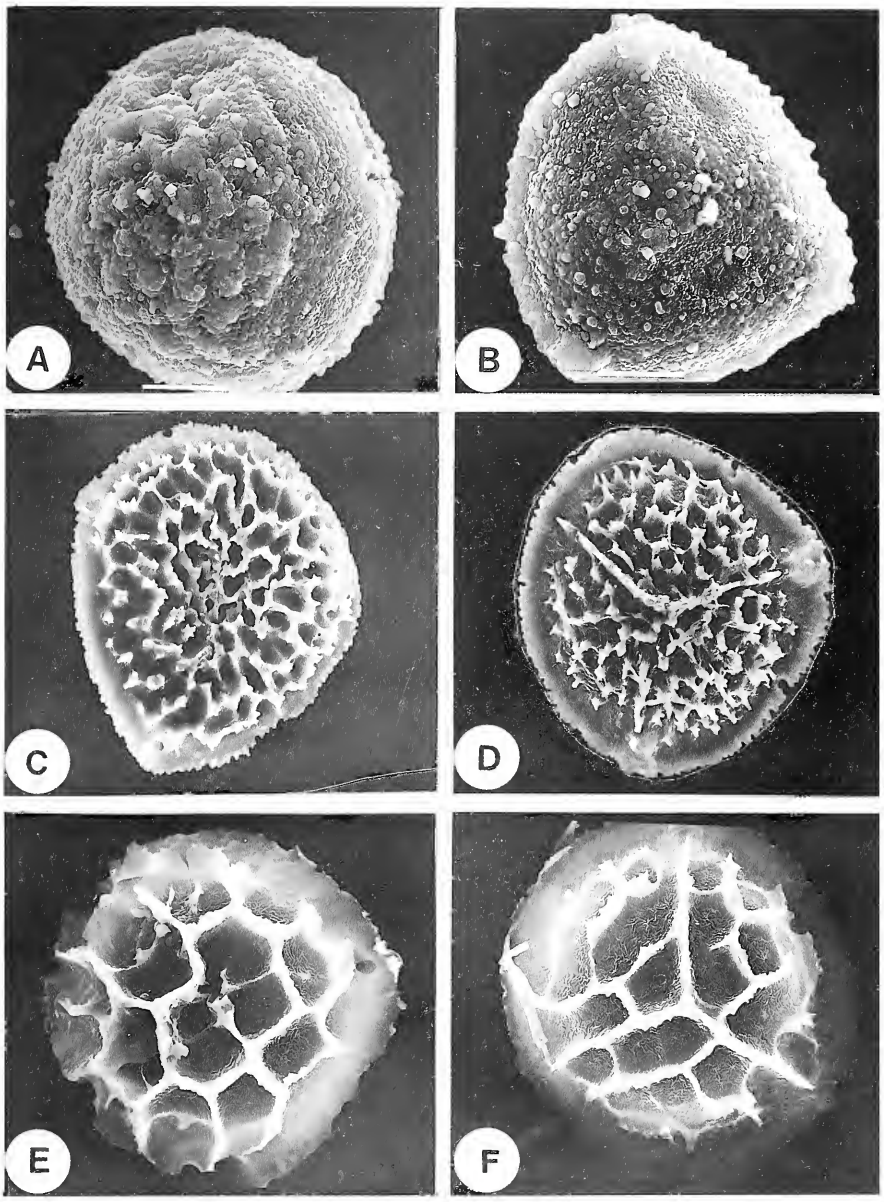

FIGURE 1.—SEM micrographs of spores. A, B, *Ricciocarpos natans*: A, distal face; B, proximal face. C, D, *Riccia crystallina*: C, distal face; D, proximal face. E, F, *R. vulcanicola*: E, distal face; F, proximal face. A, B, *Ward s.n.*; C, D, *Duthie 5313* (BOL); E, F, *Pócs 8068/158*. A–D, × 800; E, F, × 700.

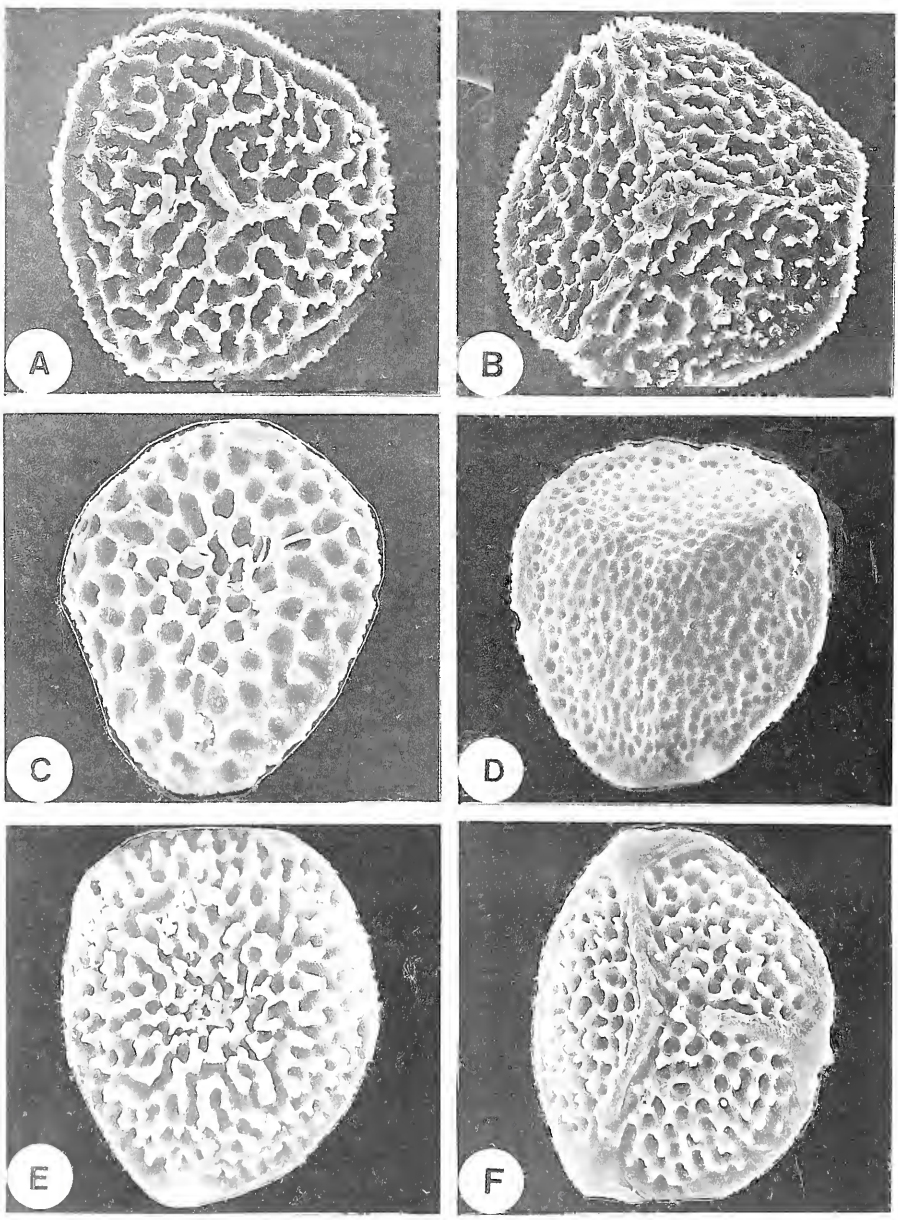

FIGURE 2.—SEM micrographs of spores. A, B, *Riccia cavernosa*: A, distal face; B, proximal face. C, D, *R. moenkemeyeri*: C, distal face; D, proximal face. E, F, *R. cupulifera*: E, distal face; F, proximal face. A, B, *Shearing 178*; C, D, *T.R. Sim 9072*; E, F, *Duthie 7471*. A–F, × 800.

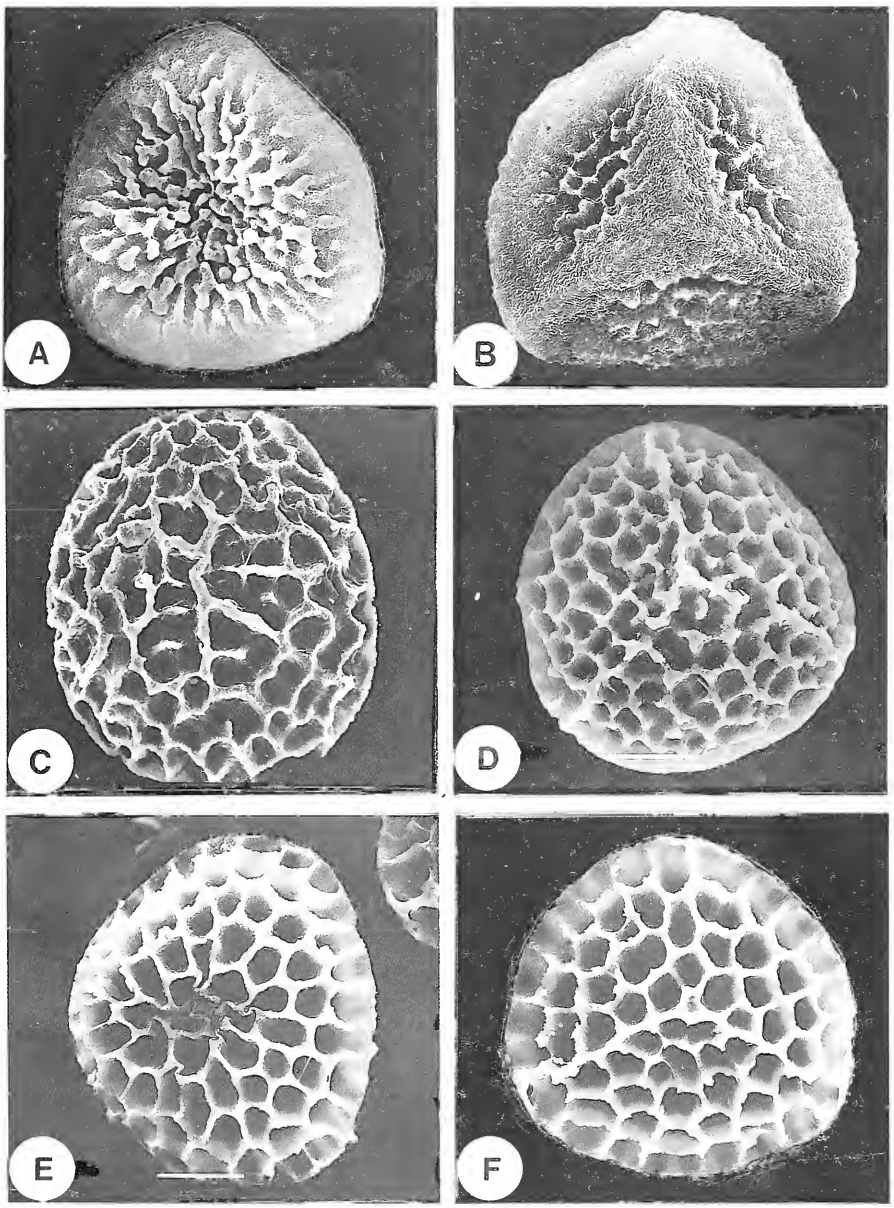

FIGURE 3.—SEM micrographs of spores. A, B, *Riccia frostii*: A, distal face; B, proximal face. C, D, *R. bullosa*: C, distal face; D, proximal face. E, F, *R. garsidei*: E, distal face; F, proximal face. A, B, *Monod 10537* (PC); C, *Duthie 5486a*; D, *S.M. Perold 467*; E, F, *S.M. Perold 536*. A, × 800; B, × 900; C, × 600; D–F, × 500.

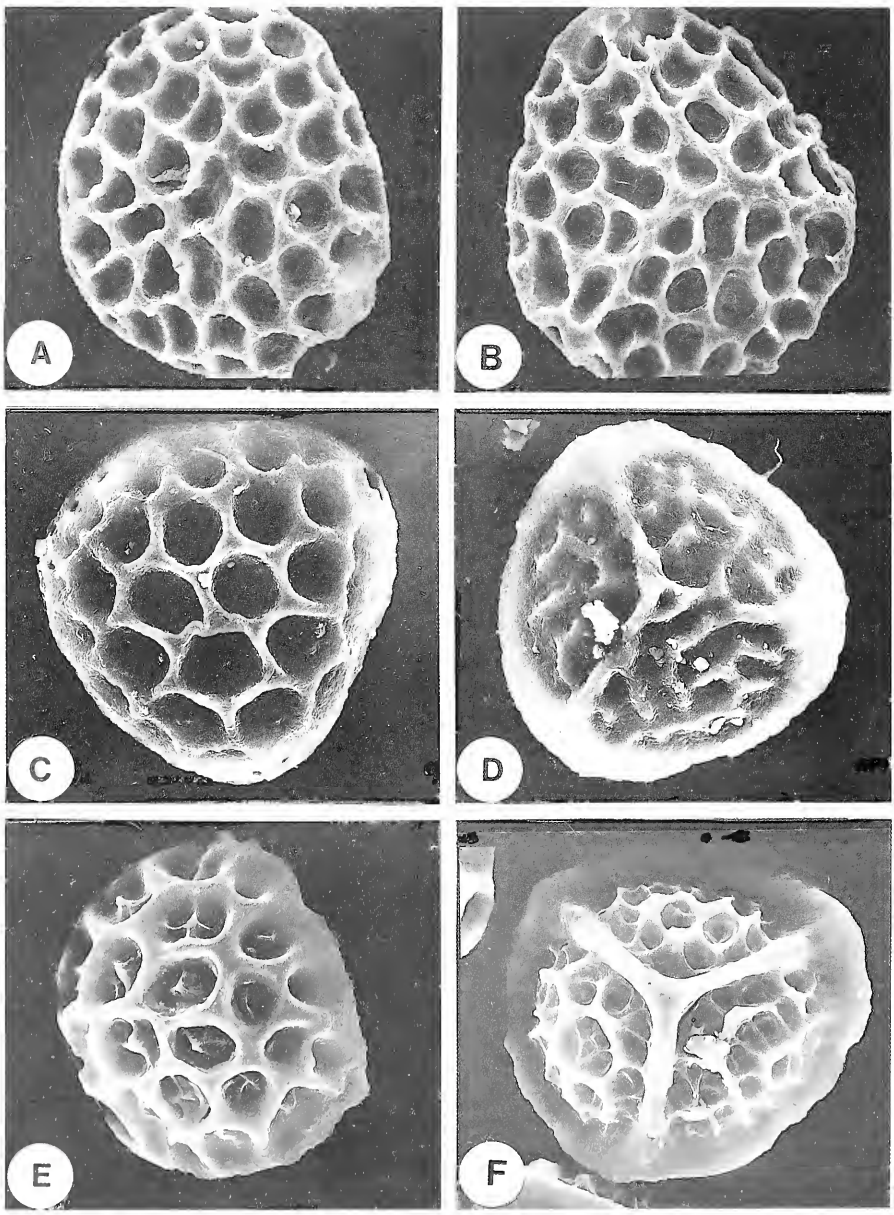

FIGURE 4.—SEM micrographs of spores. A, B, *Riccia volkii*: A, distal face; B, proximal face. C, D, *R. rubricollis*: C, distal face; D, proximal face. E, F, *R. stricta*: E, distal face; F, proximal face. A, B, *Volk 81/230*; C, D, *Duthie 5014*; E, F, *M. Koekemoer 988*. A, B, E, F, × 700; C, D, × 600.

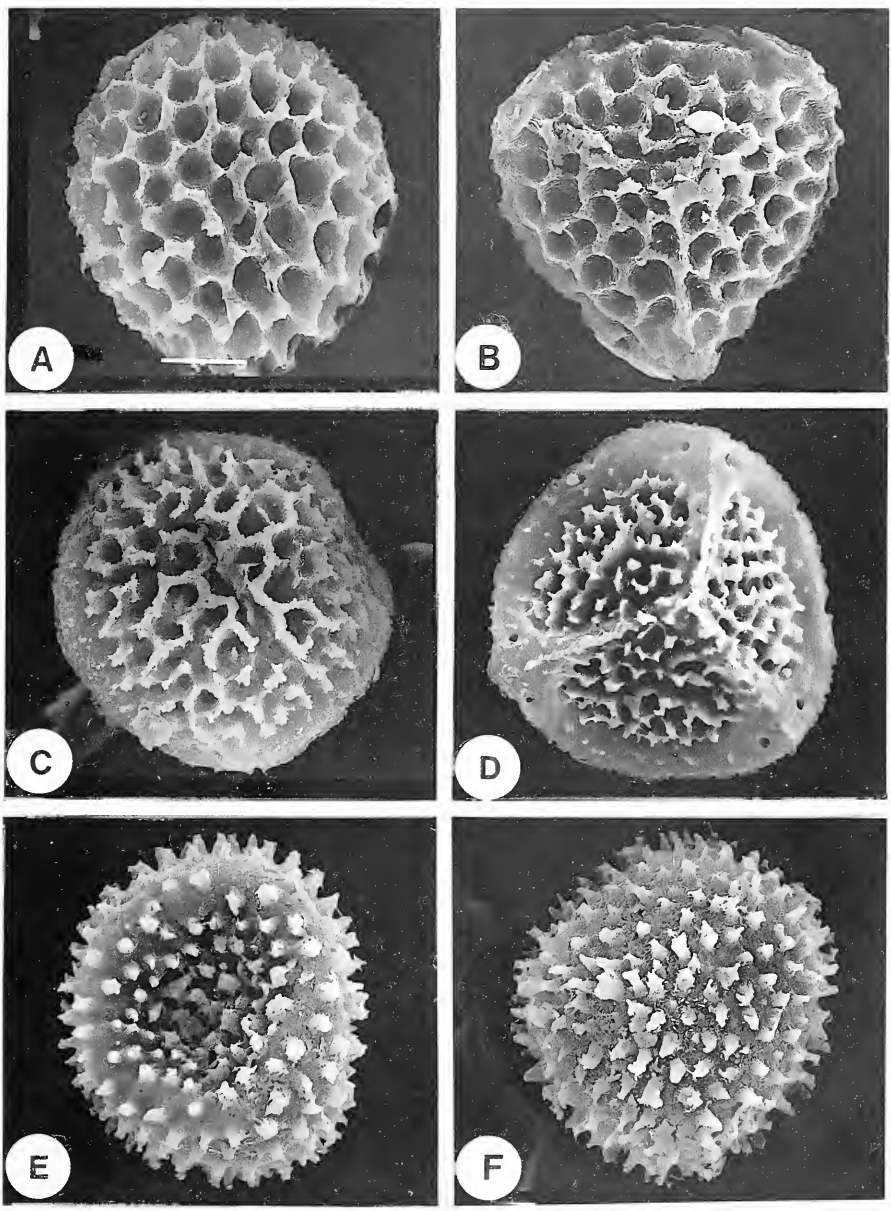

FIGURE 5.—SEM micrographs of spores. A, B, *Riccia huebeneriana*: A, distal face; B, proximal face. C, D, *R. purpurascens*: C, distal face; D, proximal face. E, F, *R. membranacea*: E, distal face; F, proximal face. A, B, *Lübenau-Nestlé s.n.*; C, D, *MacLoughlin CH4197*; E, F, *Jones 672* (BM). A, B, × 750; C, D, × 650; E, F, × 870.

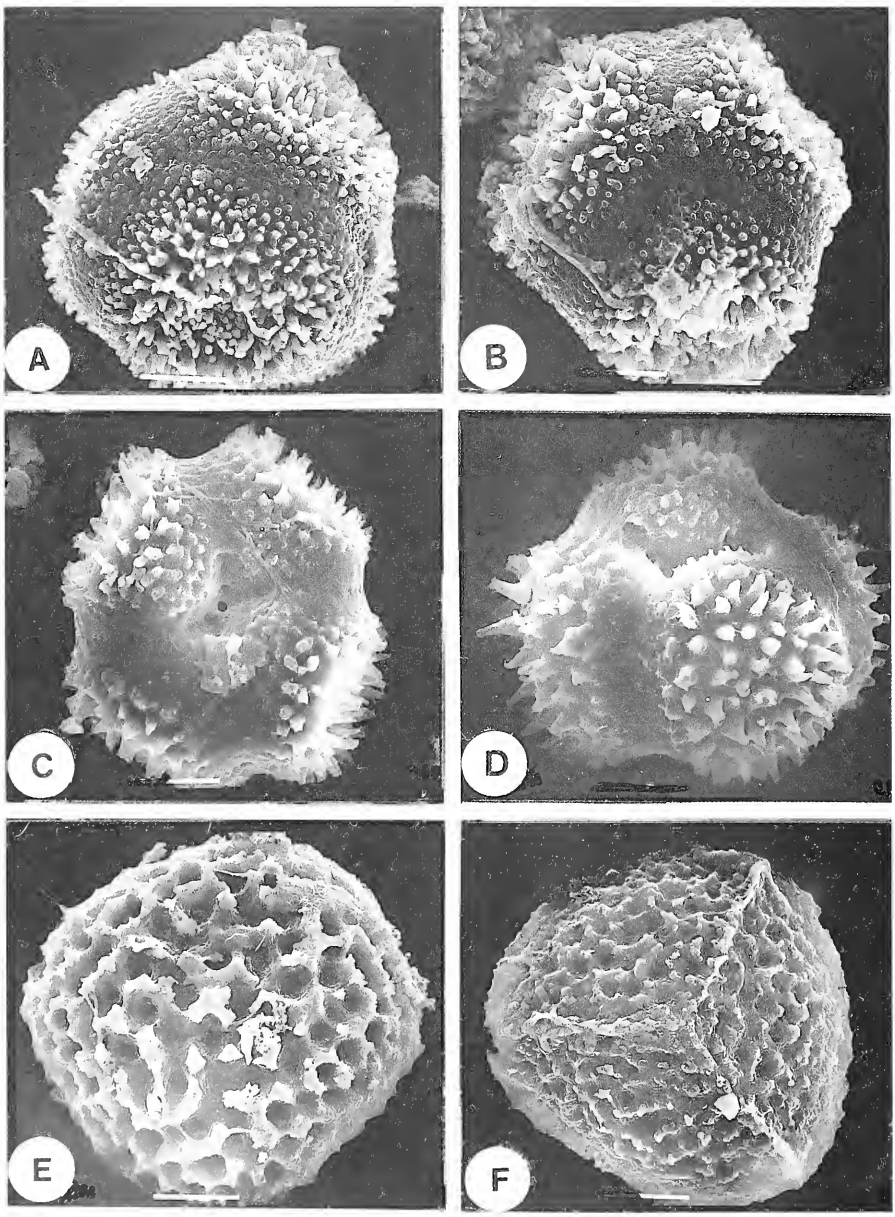

FIGURE 6.—SEM micrographs of spores. A, B, *Riccia curtisii*: A, B, tetrads. C, D, *R. perssonii*: tetrads. E, F, *R. schelpei*: E, distal face; F, proximal face. A, B, *S.M. Perold 2730*; C, D, *Volk 2059*; E, F, *C.M. van Wyk 2524*. A–D, F, × 600; E, × 550.

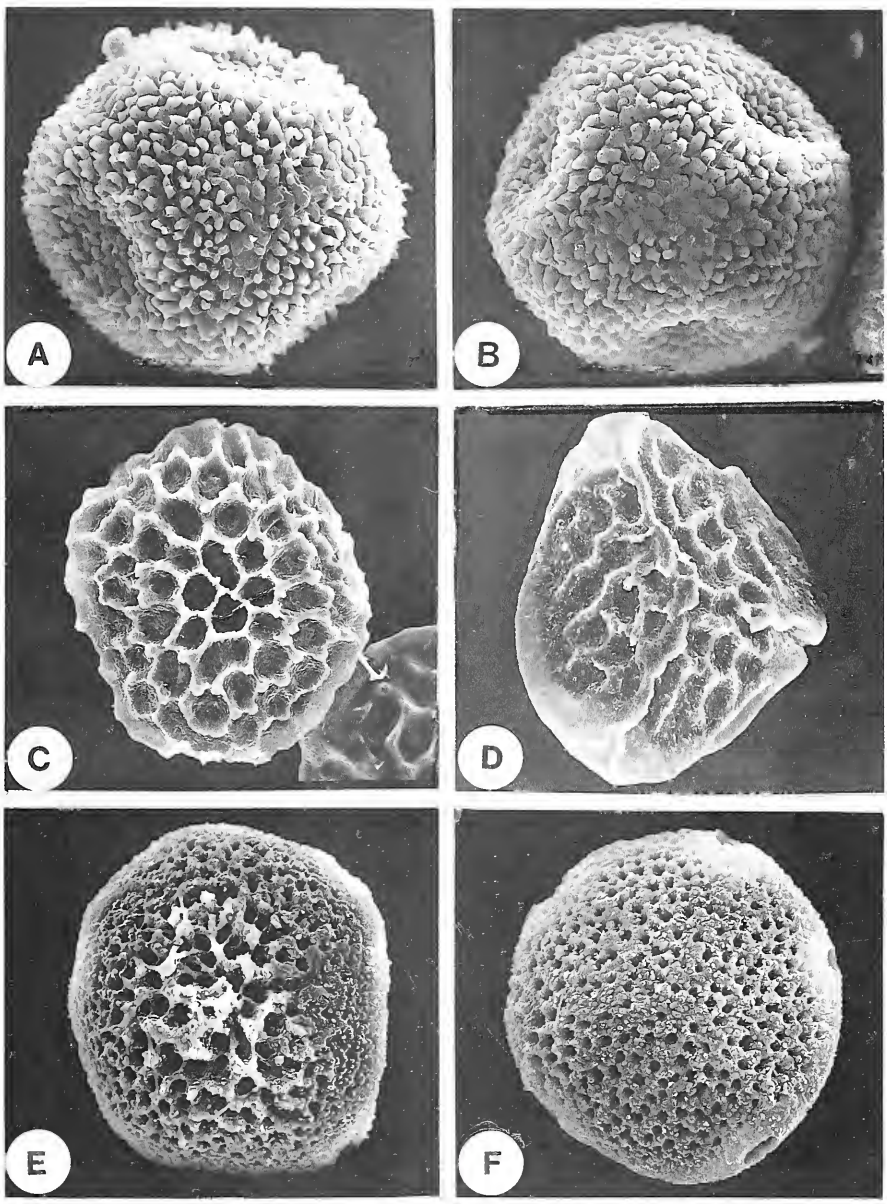

FIGURE 7.—SEM micrographs of spores. A, B, *Riccia tomentosa*: tetrads. C, D, *R. natalensis*: C, distal face; D, proximal face. E, F, *R. gougetiana*: E, distal face; F, proximal face. A, B, *S.M. Perold 1495*; C, *S.M. Perold 307*; D, *T.R. Sim 8228*; E, F, *Volk 82/980* (Herb. Volk). A–D, × 600; E, F, × 400.

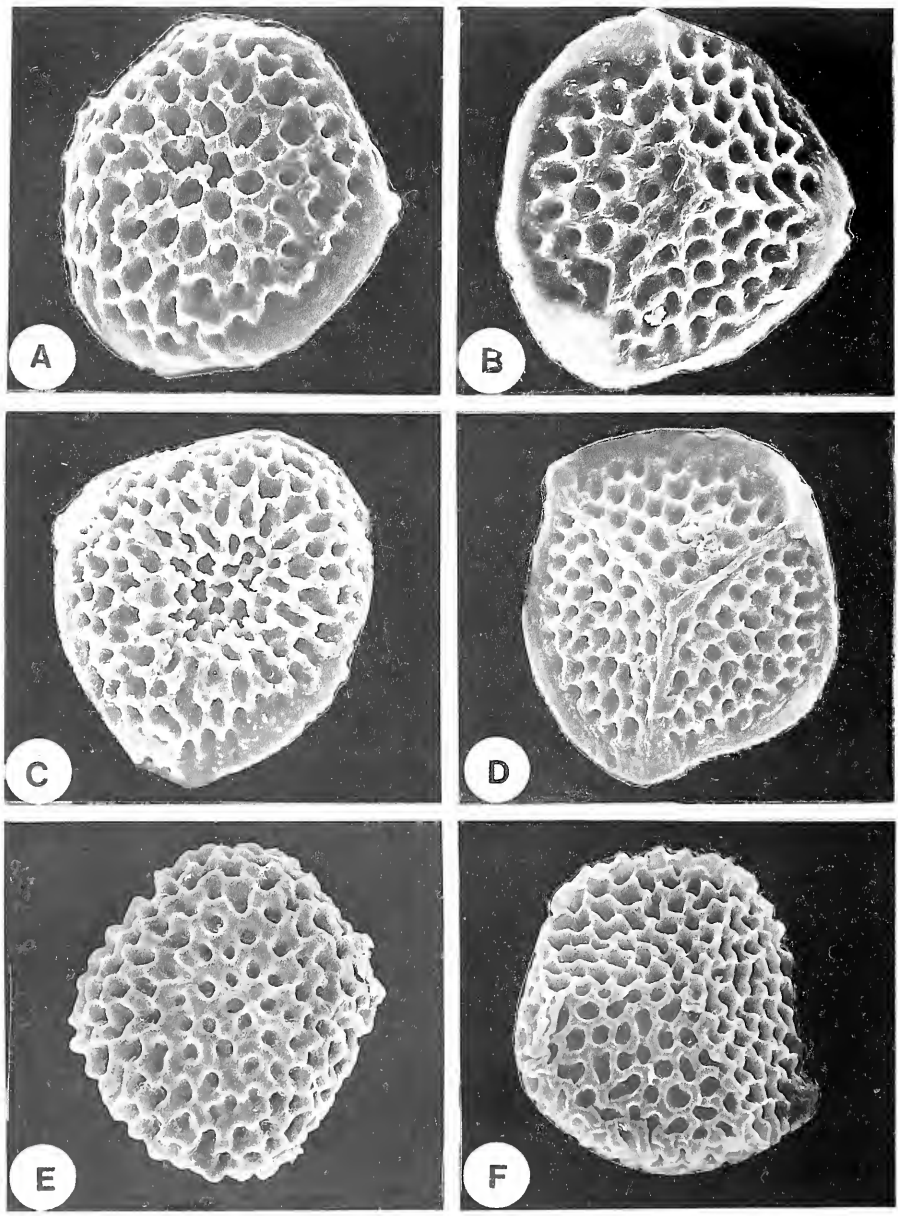

FIGURE 8.—SEM micrographs of spores. A, B, *Riccia crozalsii*: A, distal face; B, proximal face. C, D, *R. trichocarpa*: C, distal face; D, proximal face. E, F, *R. microciliata*: E, distal face; F, proximal face. A, *Duthie 5436a* (BOL); B, *Malherbe & Davies 5373* (BOL); C, D, *Toelken 5561*; E, F, *S.M. Perold 102*. A–F, × 800.

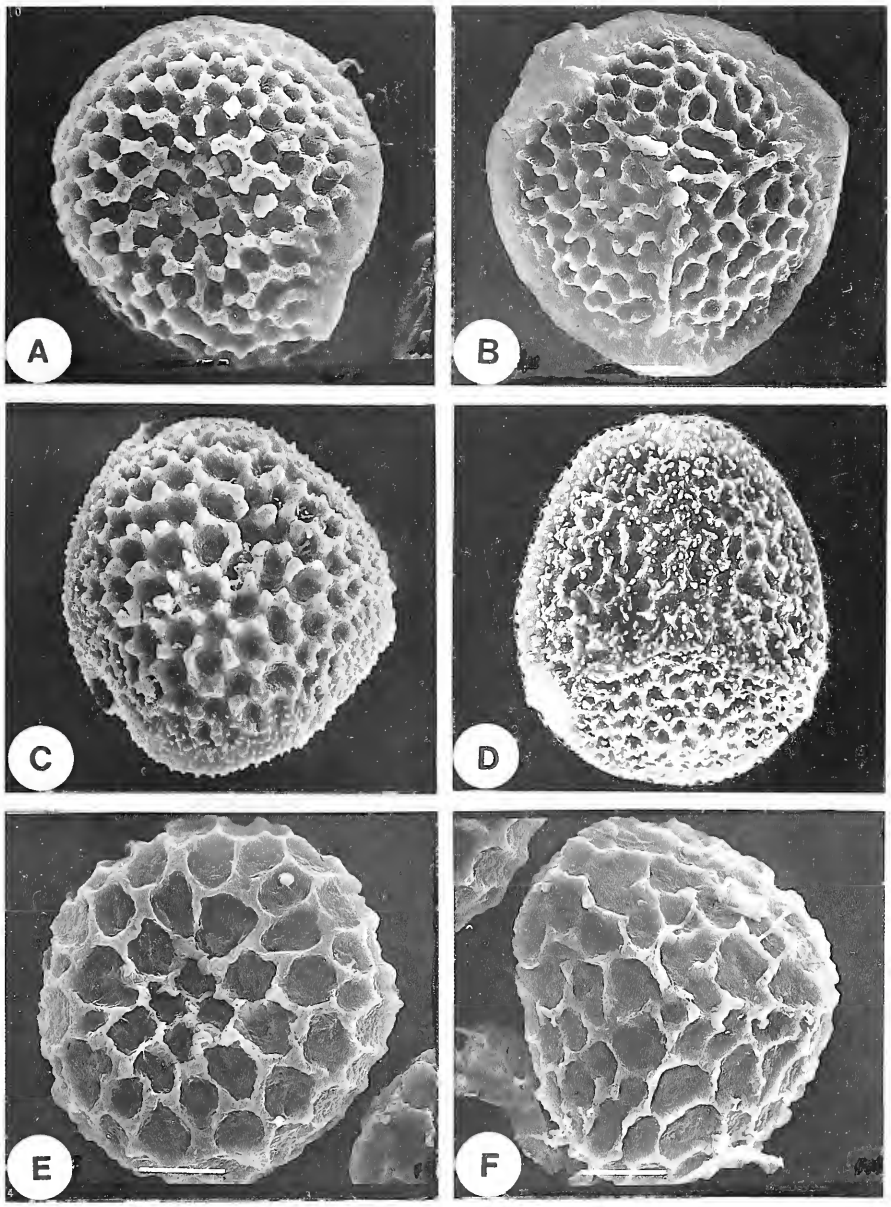

FIGURE 9.—SEM micrographs of spores. A, B, *Riccia mammifera*: A, distal face; B, proximal face. C, D, *R. sorocarpa*: C, distal face; D, proximal face. E, F, *R. nigerica*: E, distal face; F, proximal face. A, B, *S.M. Perold 447*; C, D, *S.W. Arnell 303*; E, F, *Jones 1167* (BM). A, B, × 600; C, D, × 800; E, F, × 400.

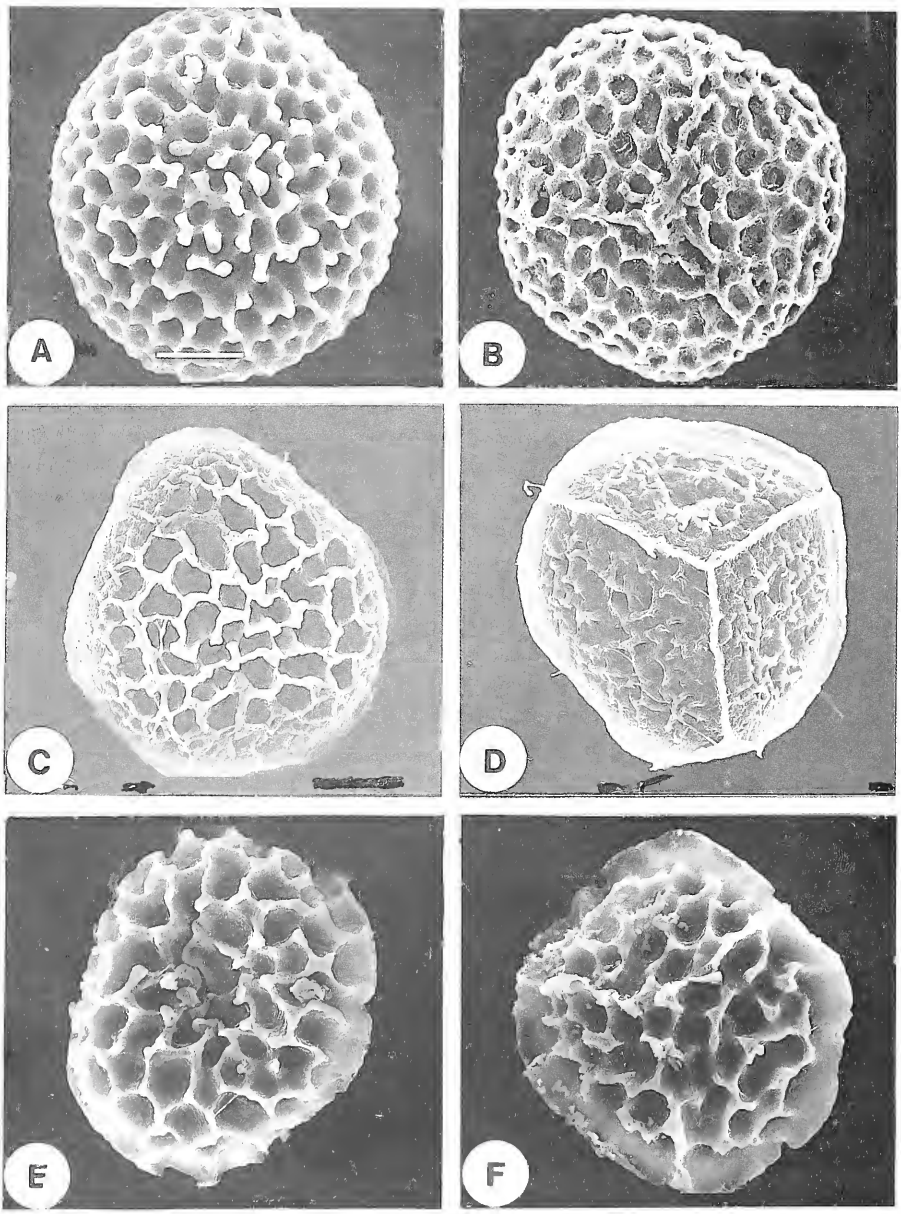

FIGURE 10.—SEM micrographs of spores. A, B, *Riccia atropurpurea*. A, distal face; B, proximal face. C, D, *R. lanceolata*: C, distal face; D, proximal face. E, F, *R. radicosa*: E, distal face; F, proximal face. A, *S.M. Perold 782b*; B, *Volk 84/710*; C, D, *Porembski & Biedinger 1313*; E, F, *Vanderyst s.n.* (BR). A, B, × 600, C, D, × 450, E, F, × 500.

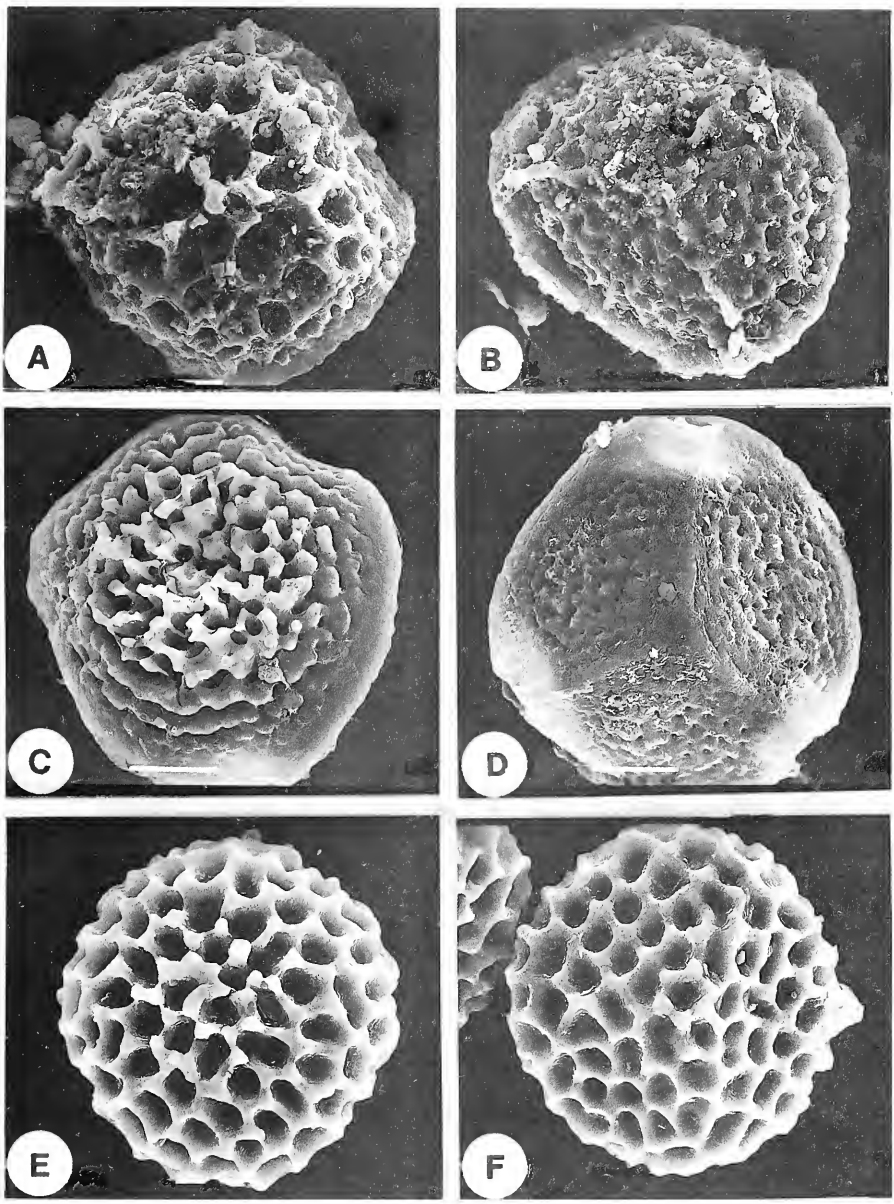

FIGURE 11.—SEM micrographs of spores. A, B, *Riccia schweinfurthii*: A, distal face; B, proximal face. C, D, *R. congoana*: C, distal face; D, proximal face. E, F, *R. limbata*: E, distal face; F, proximal face. A, B, *Schweinfurth 1832* (H); C, D, *Volk 00747a*; E, F, *Oliver 8858*. A–D, × 450; E, F, × 600.

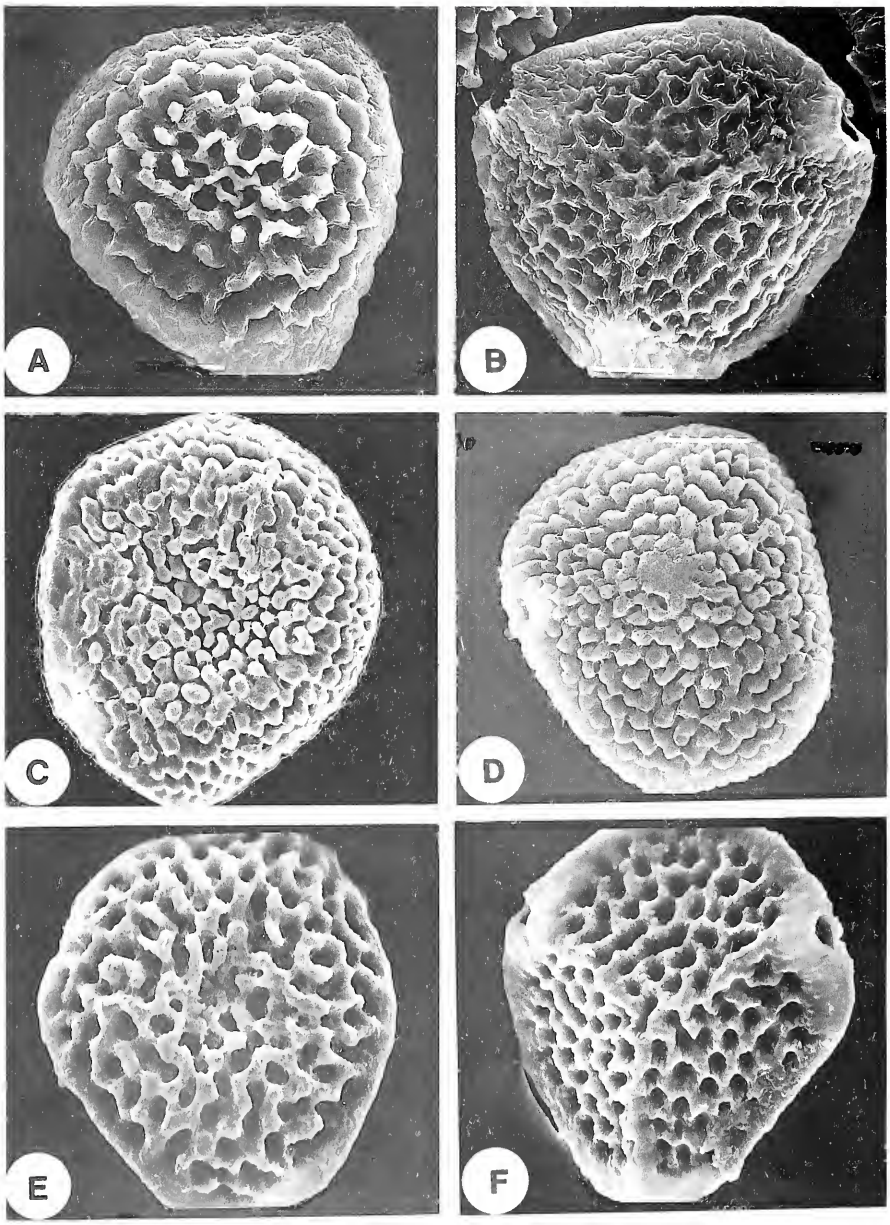

FIGURE 12.—SEM micrographs of spores. A, B, *Riccia angolensis*: A, distal face; B, proximal face. C, D, *R. okahandjana*: C, distal face; D, proximal face. E, F, *R. nigrella*: E, distal face: F, proximal face. A, B, *S.M. Perold 2466a*; C, *S.M. Perold 267*; D, *Volk 84/707*; E, F, *S.M. Perold 1147*. A–D, × 600; E, F, × 800.

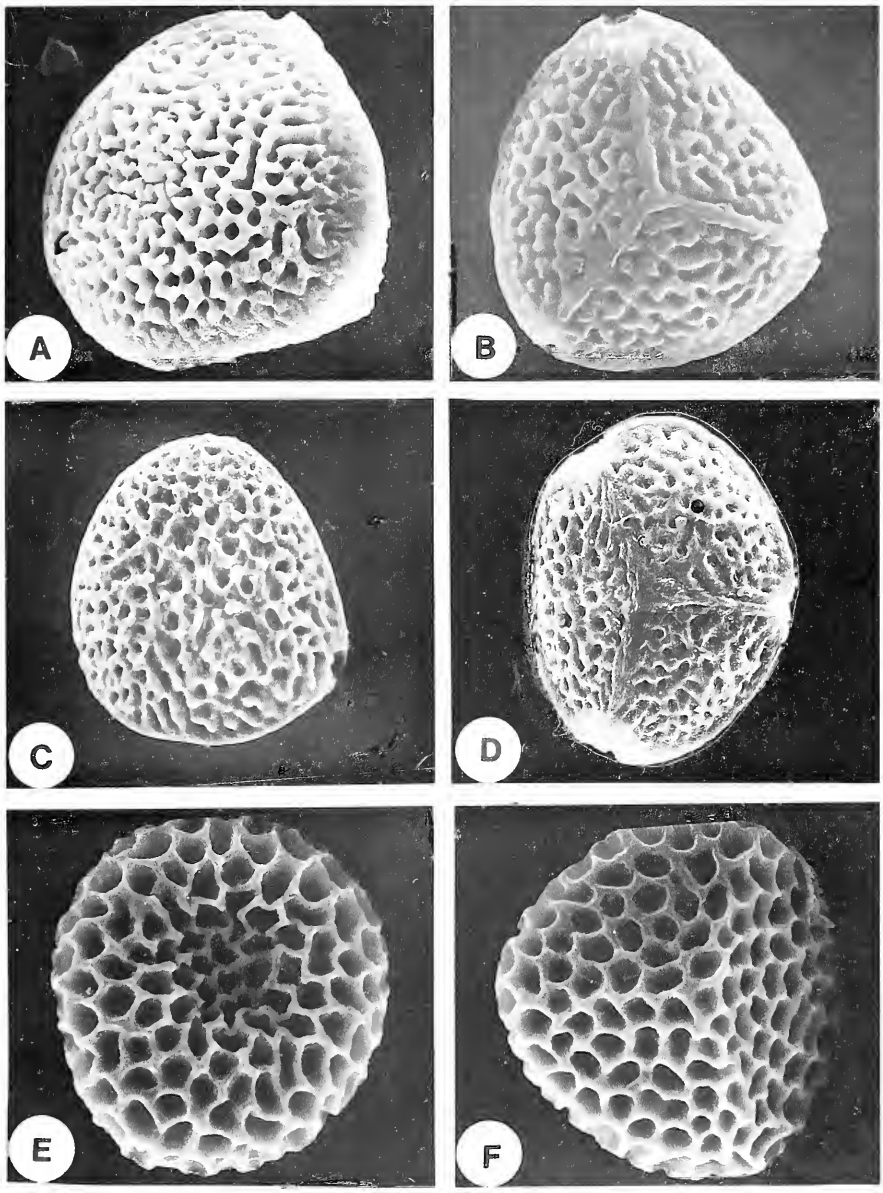

FIGURE 13.—SEM micrographs of spores. A, B, *Riccia macrocarpa*: A, distal face; B, proximal face. C, D, *R. pottsiana*: C, distal face; D, proximal face. E, F, *R. discolor*: E, distal face; F, proximal face. A, B, *S.M. Perold 888*; C, D, *Duthie 5463a* (BOL); E, F, *Bingham 8108*. A, B, × 700; C, D, × 800; E, F, × 600.

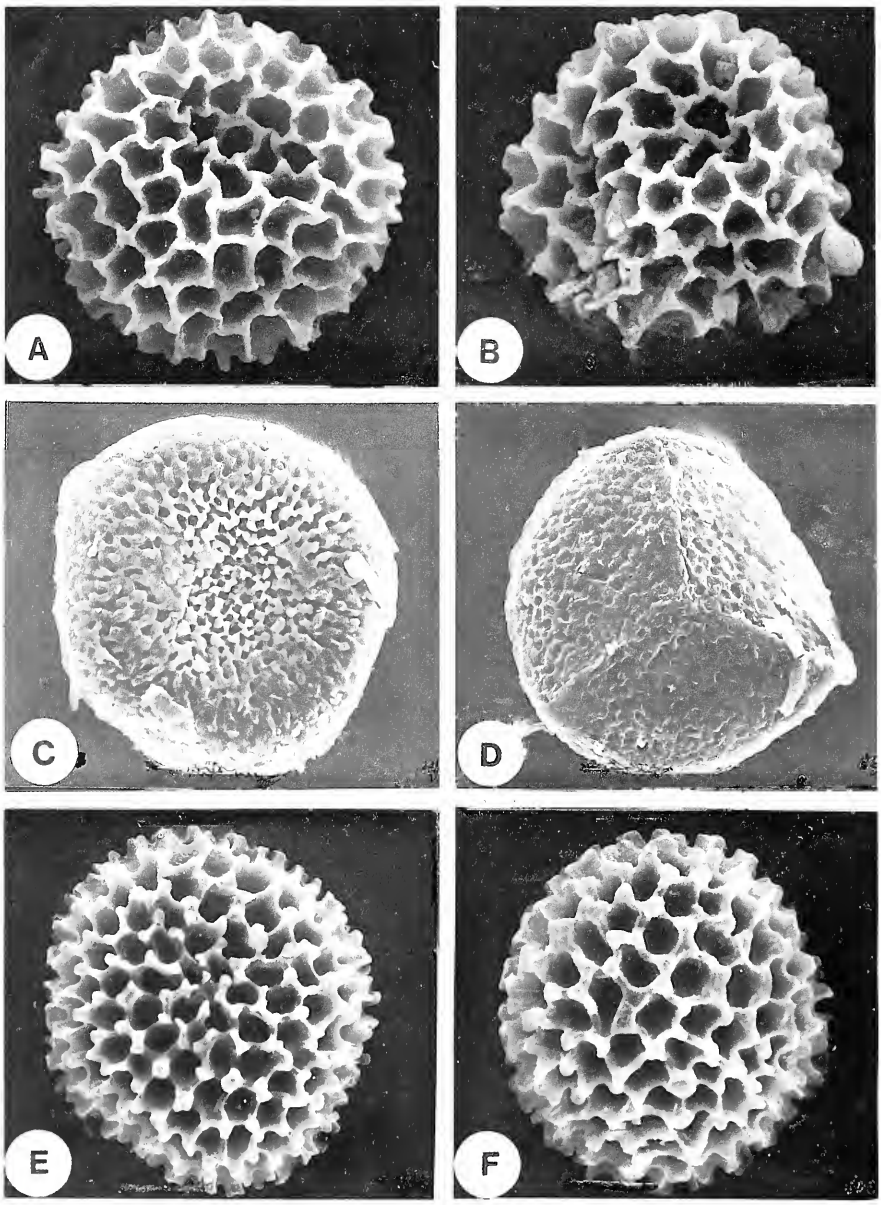

FIGURE 14.—SEM micrographs of spores. A, B, *Riccia symoensii*: A, distal face; B, proximal face. C, D, *R. erubescens*: C, distal face; D, proximal face. E, F, *R. runssorensis*: E, distal face; F, ? proximal face. A, B, *Symoens 7075* (BR); C, D, *Townsend 75/17*; E, *S.M. Perold 2466*; F, *Volk 81/125c*. A, B, × 700; C, D, × 400; E, F, × 600.

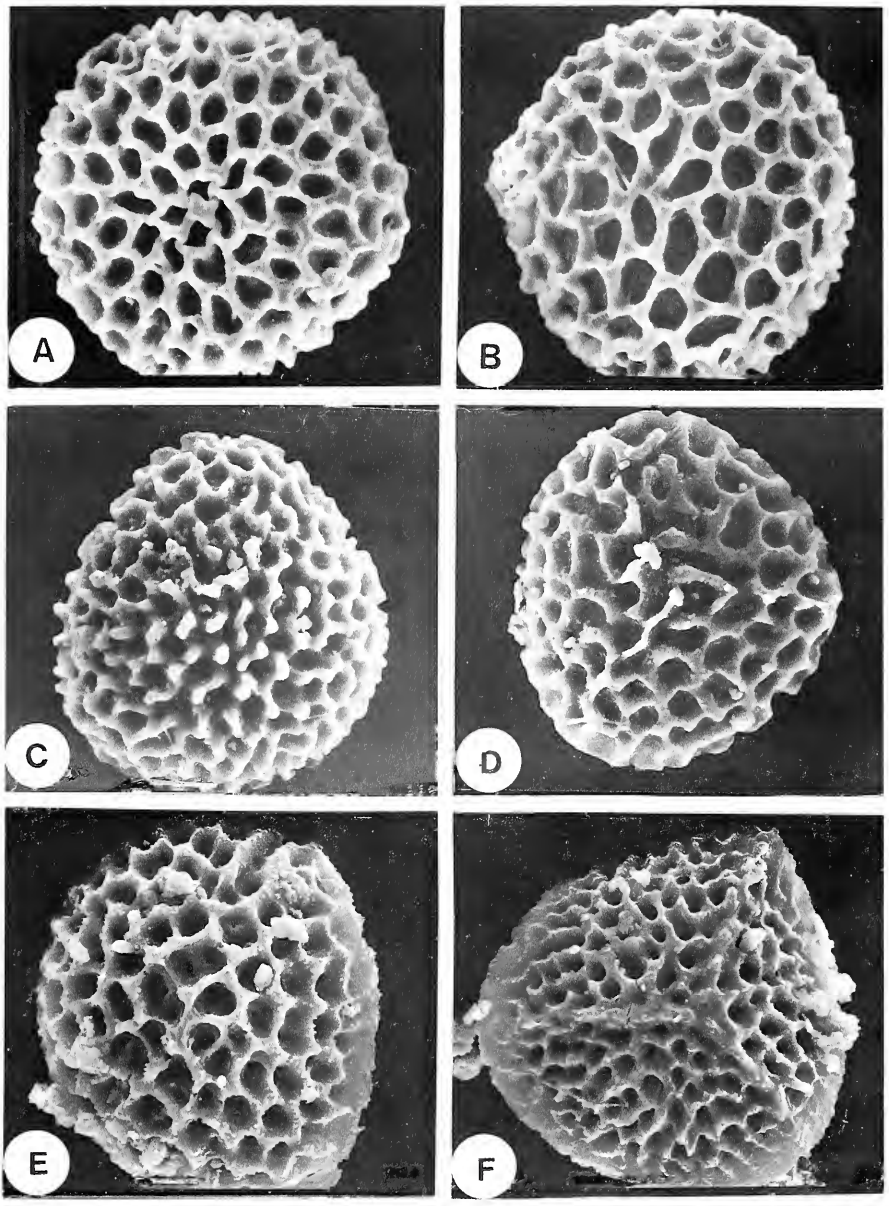

FIGURE 15.—SEM micrographs of spores. A, B, *Riccia rosea*: A, distal face; B, proximal face. C, D, *R. somaliensis*: C, distal face; D, proximal face. E, F, *R. lamellosa*: E, distal face, F, proximal face. A, B, *S.M. Perold 135a*; C, D, *Thulin & Mohamed 7110*; E, F, *Faure s.n.*(E). A, B, × 700; C, D, × 420; E, F, × 550.

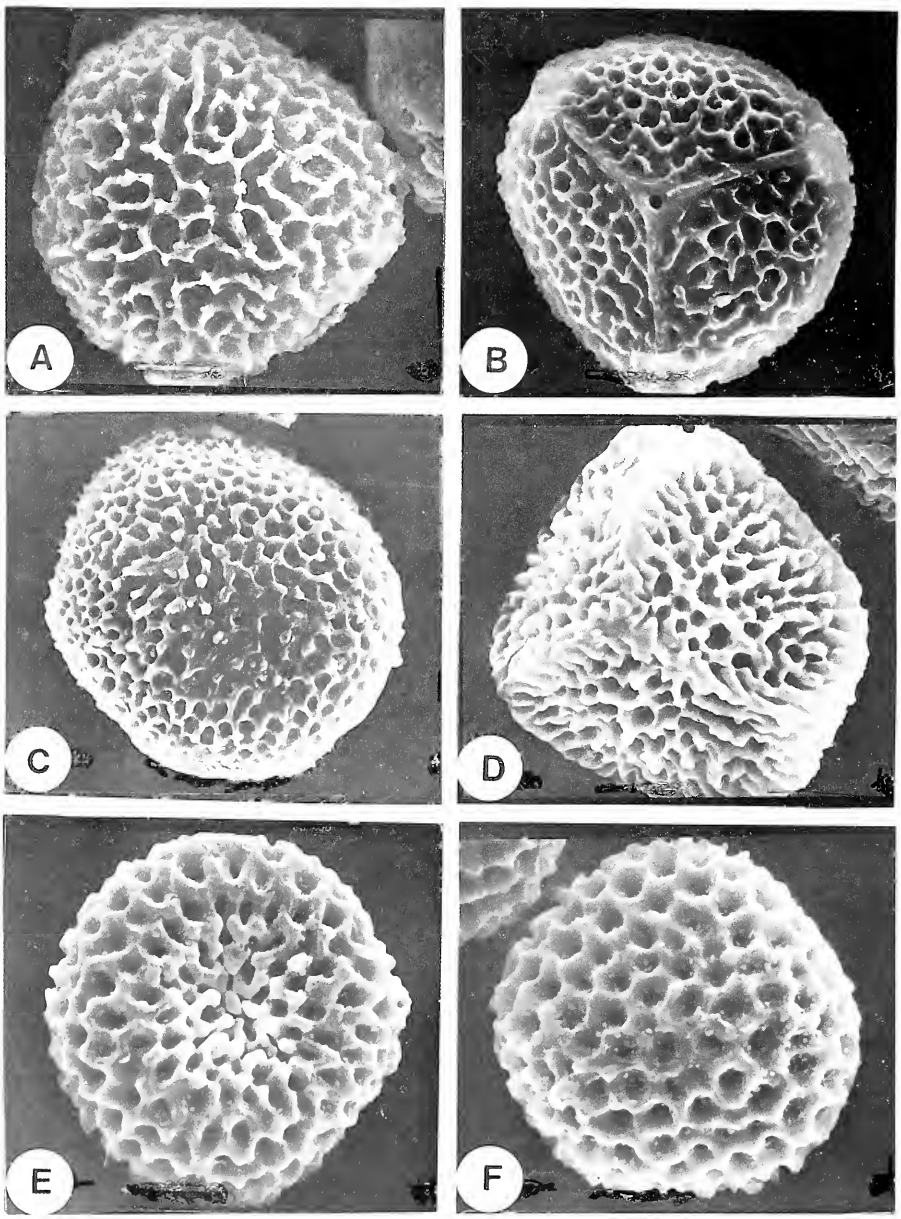

FIGURE 16.—SEM micrographs of spores. A, B, *Riccia albolimbata*: A, distal face; B, proximal face. C, D, *R. albornata*: C, distal face; D, proximal face. E, F, *R. argenteolimbata*: E, distal face; F, proximal face. A, *Volk 81/921*, B, *Stephansen 5393*, C, *Volk 81/081*; D, *Smook 6961*; E, F, *Volk 86/930a*. A, B, × 600; C, D, × 700, E, F, × 600.

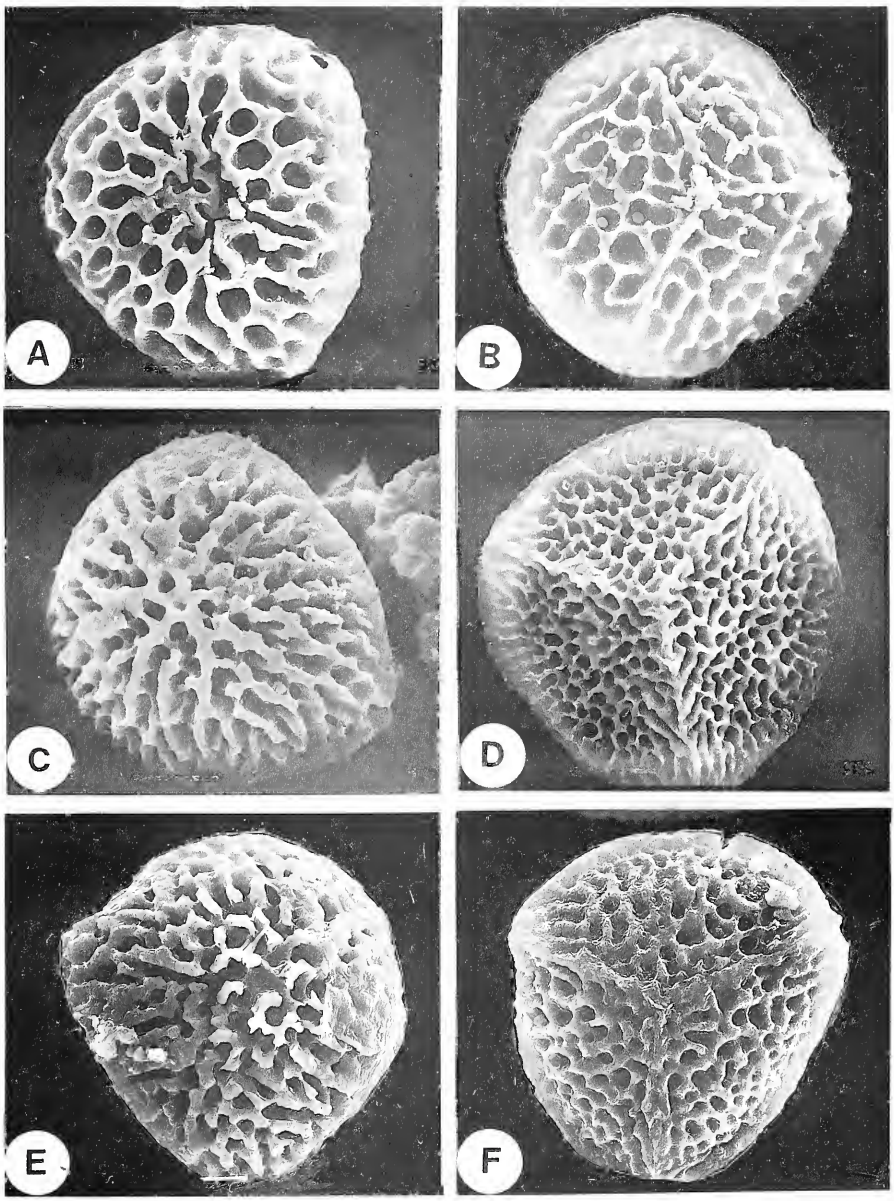

FIGURE 17.—SEM micrographs of spores. A, B, *Riccia montana*: A, distal face; B, proximal face. C, D, *R. alboporosa*: C, distal face; D, proximal face. E, F, *R. bicolorata*: E, distal face; F, proximal face. A, B, *Van Rooy 3549a*; C, D, *Oliver 8849*; E, F, *Smook 6990a*. A, B, × 800; C–F, × 700.

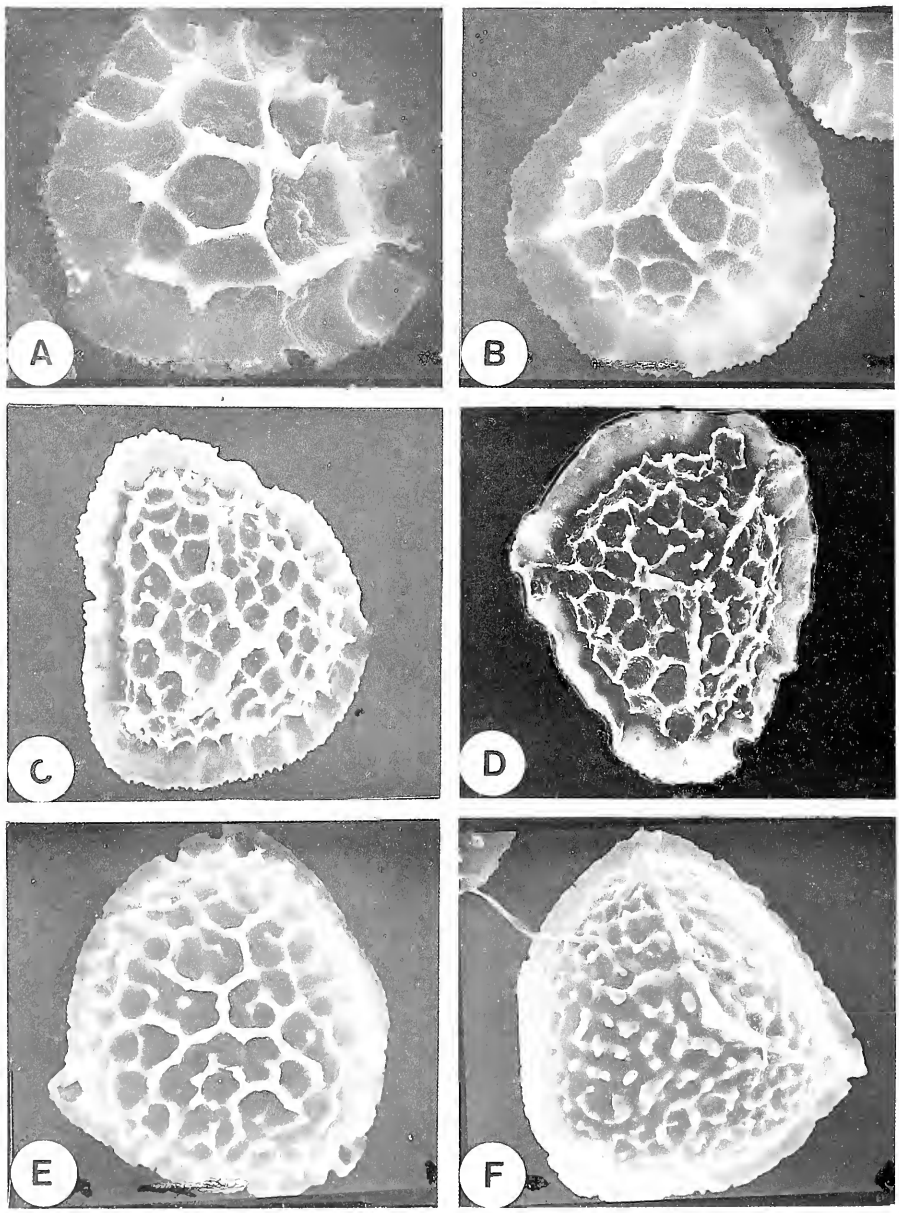

FIGURE 18.—SEM micrographs of spores. A, B, *Riccia hantamensis*: A, distal face; B, proximal face. C, D, *R. alatospora*: C, distal face; D, proximal face. E, F, *R. albovestita*: E, distal face; F, proximal face. A, B, *S.M. Perold 1830*; C, D, *Duthie 5004b*; E, F, *J.M. Perold 44*. A, B, × 800; C, D, × 500; E, F, × 700.

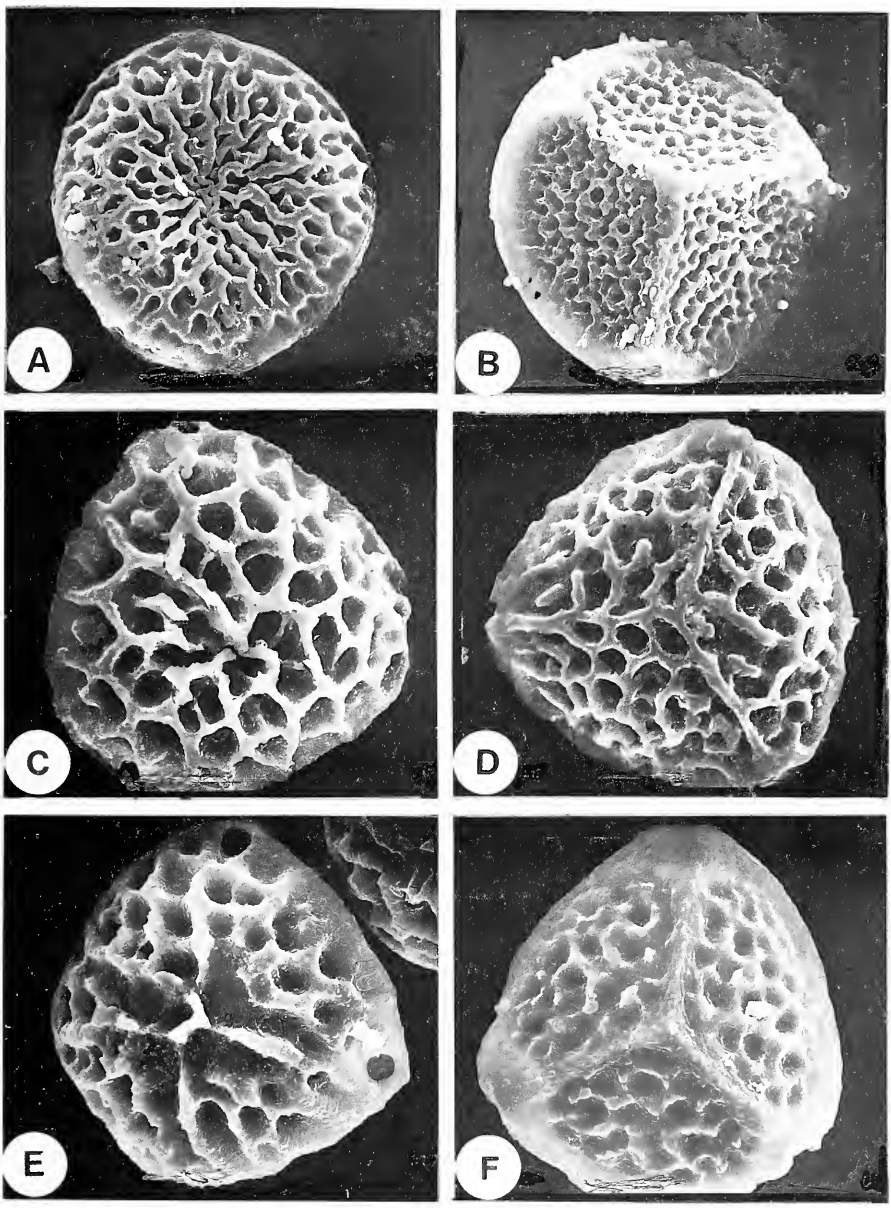

FIGURE 19.—SEM micrographs of spores. A, B, *Riccia concava*: A, distal face; B, proximal face. C, D, *R. elongata*: C, distal face; D, proximal face. E, F, *R. furfuracea*: E, distal face; F, proximal face. A, B, *S.W. Arnell 30*, C, D, *S.M. Perold 2018*; E, F, *Oliver 8957a*. A, B, × 700; C–F, × 600.

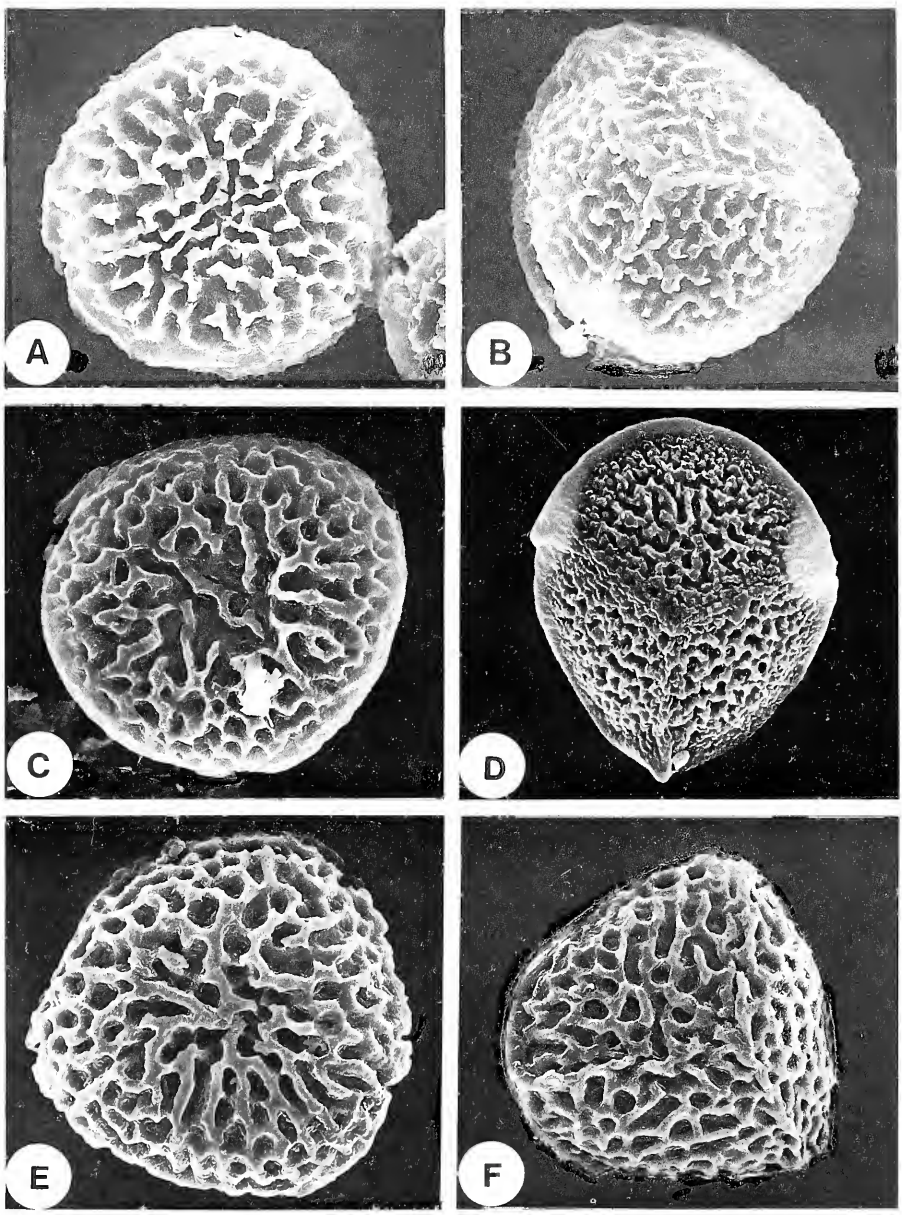

FIGURE 20.—SEM micrographs of spores. A, B, *Riccia trachyglossum*: A, distal face; B, proximal face. C, D, *R. pulveracea*: C, distal face; D, proximal face. E, F, *R. simii*: E, distal face; F, proximal face. A, B, *J.M. Perold 34*; C, *Oliver 8957a*; D, *Duthie 5484a*; E, F, *Smook 3908*. A, B, × 600; C, D, × 700; E, F, × 800.

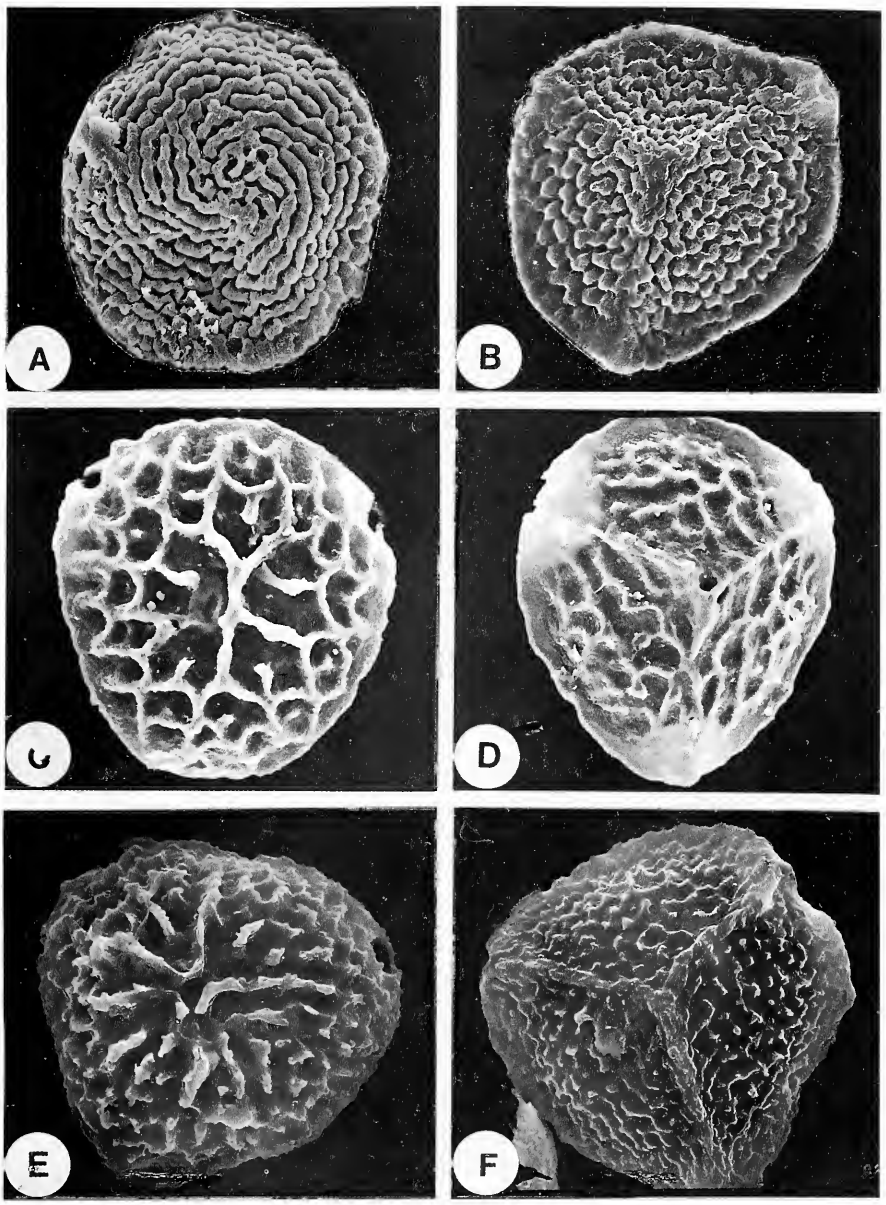

FIGURE 21.—SEM micrographs of spores. A, B, *Riccia villosa*: A, distal face; B, proximal face. C, D, *R. hirsuta*: C, distal face; D, proximal face. E, F, *R. vitrea*: E, distal face; F, proximal face. A, B, *Levyns s.n.*; C, D, *Oliver 8040*; E, F, *S.M. Perold 1425*. A, B, × 800; C–F, × 600.

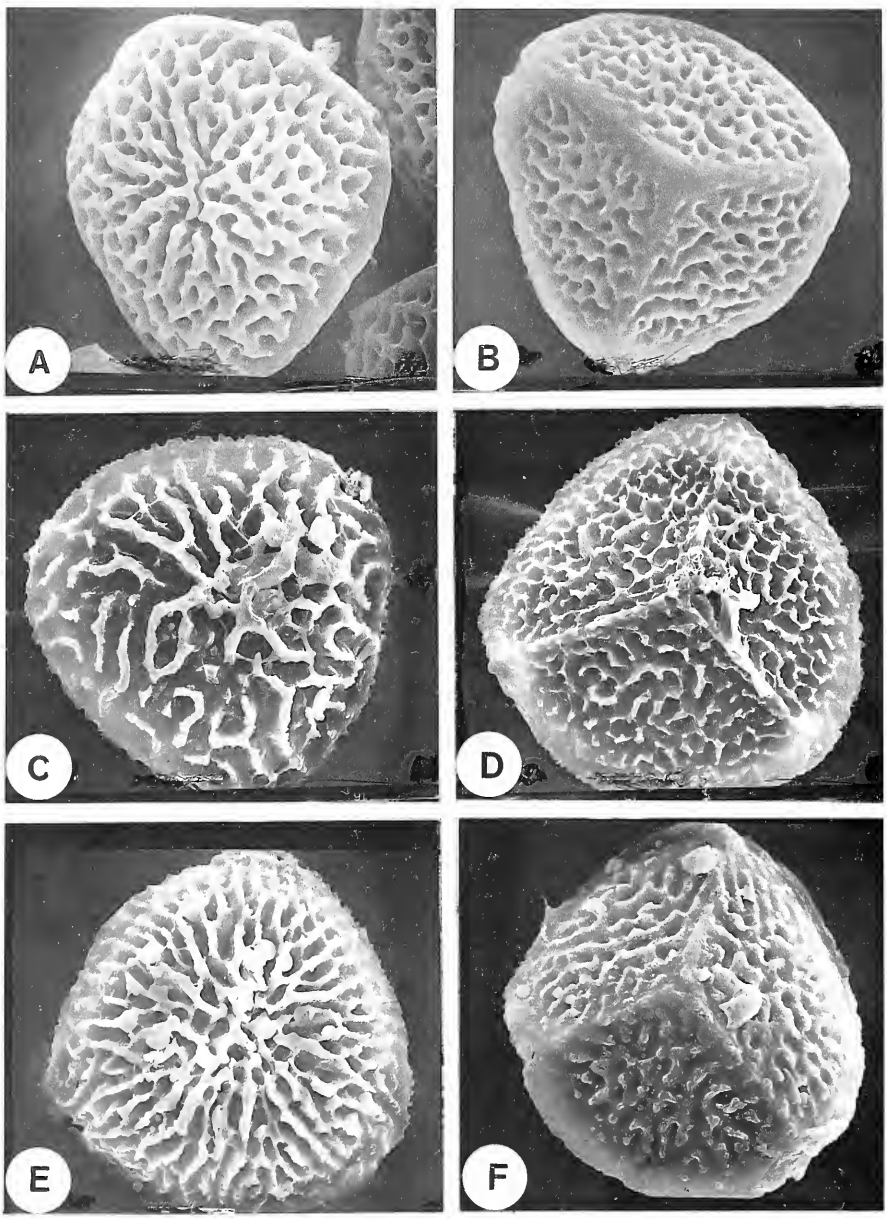

FIGURE 22.—SEM micrographs of spores. A, B, *Riccia albomarginata*. A, distal face; B, proximal face. C, D, *R. namaquensis*. C, distal face; D, proximal face. E, F, *R. ampullacea*: E, distal face; F, proximal face. A, B, *S.M. Perold 2383*; C, D, *S.M. Perold 1420*; E, F, *Van Rooy 3164a*. A, B, × 600; C, D, × 800; E, F, × 700.

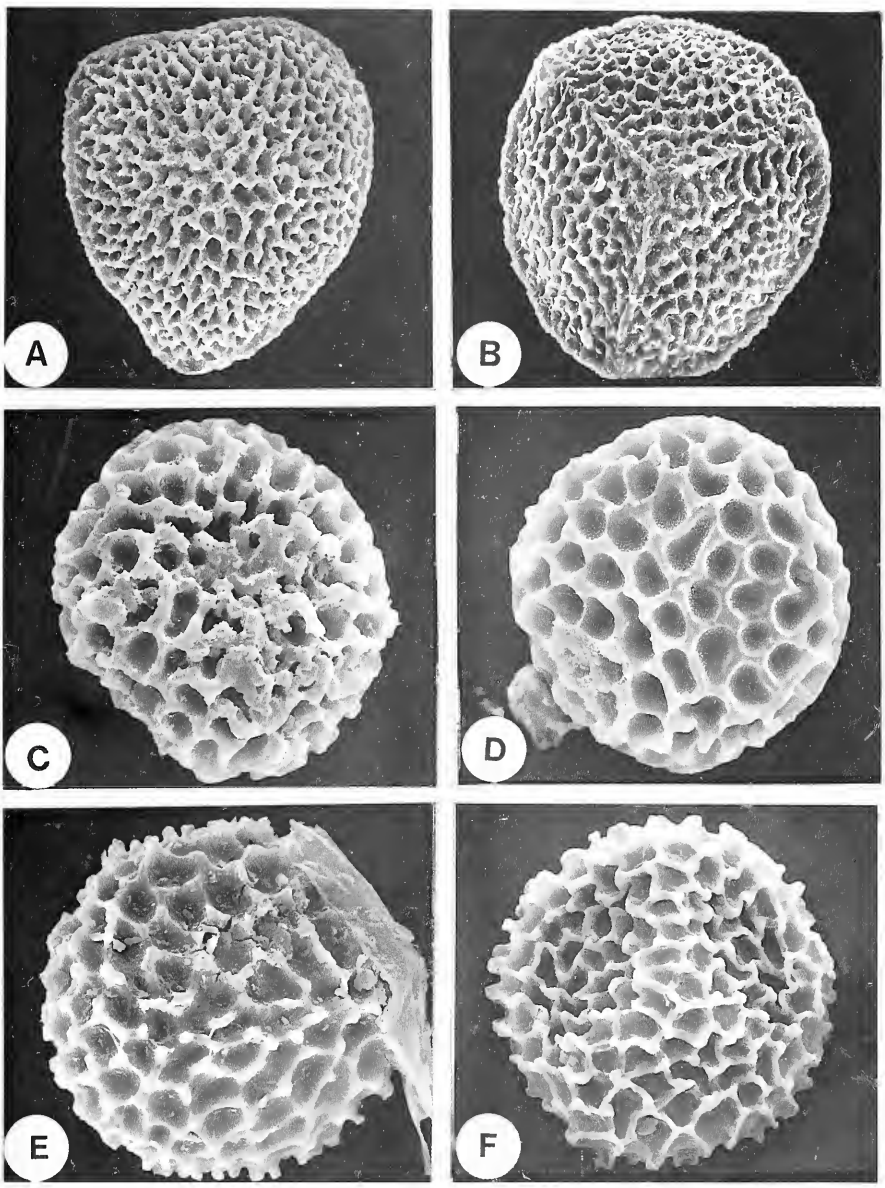

FIGURE 23.—SEM micrographs of spores. A, B, *Riccia parvo-areolata*: A, distal face; B, proximal face. C, D, *R. saharensis*: C, distal face; D, proximal face. E, F, *R. papillispora*: E, distal face; F, proximal face. A, B, *J.M. Perold 24*; C, D, *Chudeau s.n.* (G), E, F, *Beccari 802* (G). A, B, × 700, C, D, × 560, E, F, × 450.

Bothalia 26,2: 125–140 (1996)

FSA contributions 6: Orchidaceae: *Holothrix*

K.L. IMMELMAN*

1408000 HOLOTHRIX

Holothrix *Rich. ex Lindl.*, The genera and species of orchidaceous plants: 283 (1835), nom. cons.; Benth. & Hook.f. 3: 623 (1883); Schltr.: 443 (1898); Schltr.: 12 (1899a); Schltr.: 202 (1899b); Rolfe: 96 (1913); Schelpe: 66 (1966); Schelpe: 5 (1977); R.A.Dyer: 989 (1976); Immelman: 455 (1981); J.L.Stewart et al.: 58 (1982). Type: *H. parvifolia* Lindl. (1835) nom. illegit., type cons. (= *H. brevipetala* Immelman & Schelpe).

Scopularia Lindl.: t. 1701 (1834)

Monotris Lindl.: t. 1701 (1834)

Tryphia Lindl.: t. 1701 (1834)

Saccidium Lindl.: 302 (1835)

Bucculina Lindl.: 209 (1836)

Deroemera Rchb.f.: 29 (1852); Rendle: 277 (1895) as *Deroemeria*.

Terrestrial or lithophytic tuberous herbs. *Leaves* two, one sometimes much reduced (or absent?), ovate or orbicular, flat on ground, sometimes withered before flowering. *Scape* arising between two leaves, erect, unbranched, usually pubescent, with or without bracts. *Inflorescence* a spike, usually secund or subsecund. *Flowers* resupinate (except in *H. majubensis*), from 1.5 up to 25 mm long. *Sepals* subequal, sometimes connate, green, smaller than petals. *Petals* free or partly adnate to lip, green, cream, white or marked with red or purple, entire or with apex fimbriate, if entire then apices either thickened and fleshy or whole petal membranous; *lip* fleshy or membranous, entire or divided into three to many lobes, sometimes fimbriate, coloured as for petals, produced into a spur. *Column* usually small, simple and erect, fused basally to lip, in one species forming an open arch; anther sacs above stigma; rostellum much reduced. *Pollinia* two, in anther sacs, granular, each with a short caudicle and separate viscidium; viscidia naked, often resting on small flaps of tissue on either side of column.

Species about 55, distributed from Arabia through eastern and West tropical Africa, and the Cameroons, to South Africa; also in Madagascar, the Comoro Islands and Socotra. There are 23 species in southern Africa, with the greatest concentration in the Western Cape (see Guide for authors to *Bothalia*, p. 208: figure 1).

All measurements of lip and petal breadth are taken across the base of the lobes where these occur, except where otherwise stated. In undivided petals and lip the breadth is taken at the broadest point. Length is the total length of lip or petal. Scape length is also the total length of the scape, including the flowering portion.

In some of the species, details of flower colour, inflorescence and papillae are given. This has been possible where living or pickled specimens were seen. It is of interest to note that in all these the anther sacs are usually a darker and contrasting colour to the rest of the column, and to the flower as a whole.

Holothrix is derived from the Greek words for 'completely hairy', and refers to the squamous or hispid vegetative parts of the type species.

Key to southern African species of *Holothrix*

1a Scape with bracts:
  2a Petals entire . . . . . 19. *H. culveri*
  2b Petals divided:
    3a Flowers dimorphic . . . . . 20. *H. burchellii*
    3b Flowers not dimorphic:
      4a Lip lobes filamentous; Gauteng and Northern Province . . . . . 21. *H. randii*
      4b Lip lobes thickened; Northern, Western and Eastern Cape:
        5a Spur ½ to nearly equal length of lip; scape with a covering of short, fine, somewhat velvety hairs . . . . . 22. *H. schlechteriana*
        5b Spur 1/5–1/4 length of lip; scape usually glabrous but sometimes with a few short hairs at base . . . . . 23. *H. grandiflora*
1b Scape without bracts:
  6a Petals divided at apex into 3 or 5 lobes:
    7a Spur 1¼–2 times length of lip; petals 5-lobed; Namaqualand (Northern Cape) . . . . . 12. *H. filicornis*
    7b Spur ¼–equal length of lip; petals 3-lobed; Eastern Cape, KwaZulu-Natal, Lesotho, Mpumalanga . . . . . 13. *H. scopularia*
  6b Petals entire:
    8a Petals green or cream, carnose at apices:
      9a Flowers not resupinate . . . . . 7. *H. majubensis*
      9b Flowers resupinate:
        10a Petals linear; lip lobes short and triangular with obtuse apices . . . . . 1. *H. pilosa*
        10b Petals broader at centre than at apex; lip lobes various:
          11a Lip entire or three-lobed:
            12a Spur longer than lip . . . . . 2. *H. longicornu*
            12b Spur shorter than lip:

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MS. received: 1990-01-30.

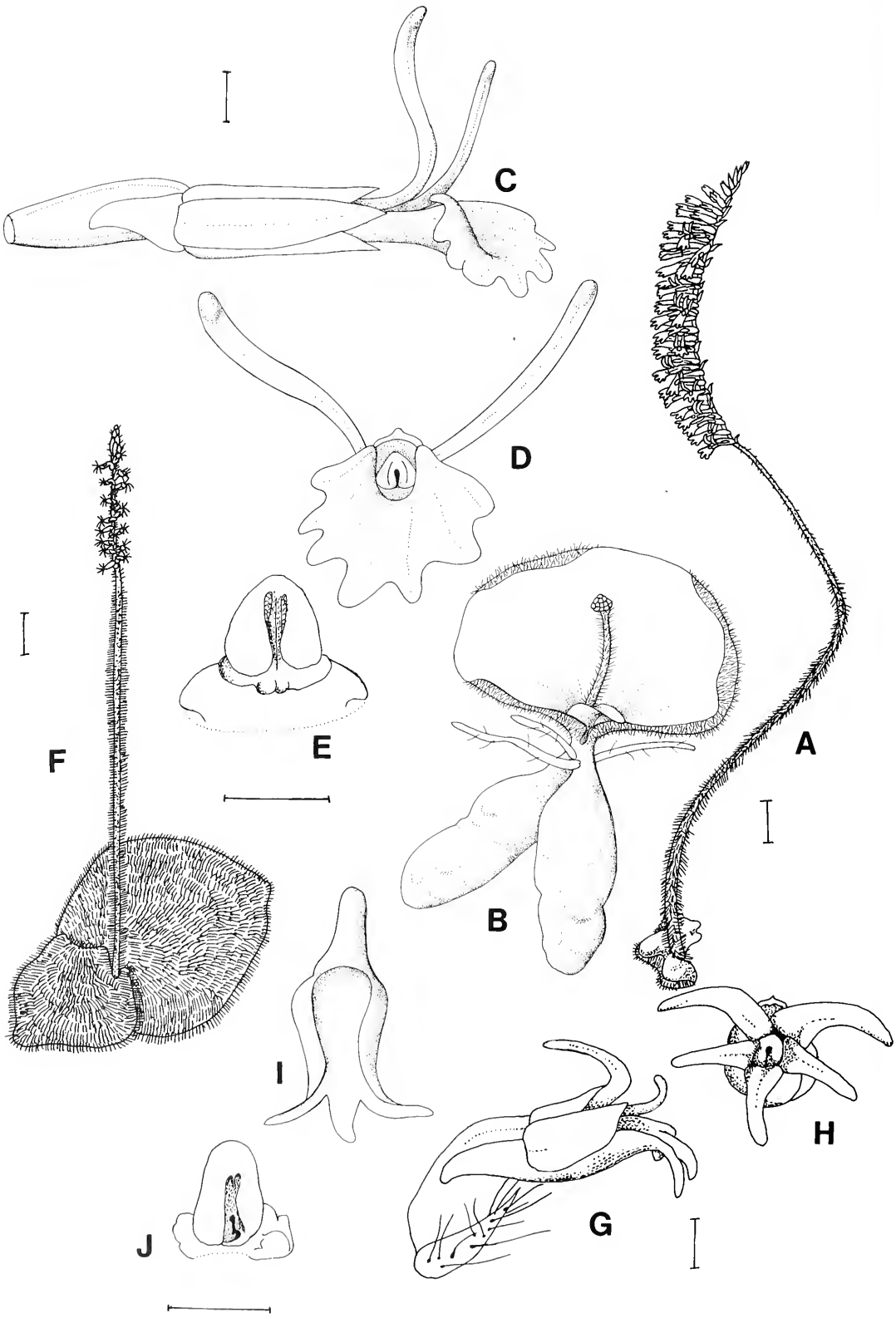

FIGURE 1.—A–E, *Holothrix pilosa, Schelpe s.n.*: A, habit; B, plant with leaf before shrivelling and tubers; C, flower, side view; D, flower, front view; E, column. F–J, *H. villosa* var. *villosa, Esterhuysen s.n.*: F, habit; G, flower, side view; H, flower, front view; I, lip from above; J, column. A, E–H, J, drawn by K. Immelman; B–D, I, drawn by G. Condy. Scale bars: A, B, F, 10 mm; C–E, G–J, 1 mm.

13a Lip entire . . . . . 3. *H. exilis*
13b Lip 3-lobed:
14a Breadth of central lip lobe at least half its length . . . . . 4. *H. brevipetala*
14b Breadth of central lip lobe less than half its length, linear:
15a Lip lobes subequal in length:
16a Hairs on leaves usually broad and flattened (squamules), these rarely restricted to margins, hairs on scape reflexed and hispid . . . . . 5. *H. cernua*
16b Leaves villous, hairs on scape at right angles to scape:
17a Scape slender; inflorescence lax; lip lobes narrowly linear . . . . . 6a. *H. villosa* var. *villosa*
17b Scape short and stout; inflorescence dense; lip lobes broadly linear . . . . . 6b. *H. villosa* var. *condensata*
15b Side lobes of lip half or less than half of length of central lobe:
18a Leaf usually withered at anthesis, with hispid hairs; Drakensberg . . . . . 8. *H. thodei*
18b Leaf not usually withered at anthesis, with fine soft hairs, Western and Eastern Cape, mainly lowland . . . . . 3. *H. exilis*
11b Lip lobes 5–7:
19a Gauteng, Free State, Lesotho, KwaZulu-Natal, if Eastern Cape then montane and hairs villous:
20a Petals more than 5 mm long; flowering December to April . . . . . 10. *H. incurva*
20b Petals less than 5 mm long; flowering September and October . . . . . 11. *H. micrantha*
19b Western Cape, if Eastern Cape then not montane and hairs squamous or hispid:
21a Spur longer than lip . . . . . 2. *H. longicornu*
21b Spur shorter than lip:
22a Base of petals adnate to lip; leaves glabrous . . . . . 9. *H. secunda*
22b Petals free from lip; leaves with hairs or squamules:
23a Length of lip lobes usually less than twice the breadth . . . . . 4. *H. brevipetala*
23b Lip lobes linear, more than twice as long as broad . . . . . 5. *H. cernua*
8b Petals white, membranous at apices:
24a Lip lobes 5:
25a Spur circinnate; leaves uniform in colour; bases of petals adnate to lip . . . . . 14. *H. parviflora*
25b Spur straight; leaves veined with white; petals free from lip . . . . . 15. *H. orthoceras*
24b Lip lobes 7 or more, or indefinite with lip serrate along margin:
26a Lip lobes 7:
27a Lip lobes acute, broadly triangular except for a longer and narrower lobe on either side; petals tapering to an acuminate apex; leaves veined with white; east of Port Elizabeth . . . . . 15. *H. orthoceras*
27b Lip lobes truncate or obtuse, lobes on either side of central lobe shorter than central lobe; petal apices rounded; leaves uniformly green; mostly west of Port Elizabeth:
28a Inflorescence condensed at apex of spike; spur short and straight . . . . . 16. *H. mundii*
28b Inflorescence lax; spur curved abruptly forward under lip . . . . . 17. *H. aspera*
26b Lip lobes more than 7, or lip serrated:
29a Outermost lip lobe on either side longer than central lobes; leaves veined with white; Northern Province to Eastern Cape . . . . . 15. *H. orthoceras*
29b Lobes of lip subequal, very short, giving lip a serrated appearance; leaves not veined with white; Eastern Cape . . . . . 18. *H. macowaniana*

1. **Holothrix pilosa** *(Burch. ex Lindl.) Rchb.f.* in Otia botanica hamburgensia: 119 (1881); J.L.Stewart et al.: 60 (1982). Type: Swellendam Div., on a dry hill east of Breede River, *Burchell 7483* (K!).

Saccidium pilosum Lindl.: 302 (1835).

Leaves large, succulent, upper surface glabrous, rarely with hairs, undersurface densely pilose with long, fine hairs, usually withered at anthesis; upper leaf reduced in size. *Scape* without bracts, 160–550 mm long, densely pilose with long, fine hairs, hairs recurved at base of scape, at right angles to scape at its apex. *Inflorescence* secund. *Sepals* 2.5–5.0 × 1.0–2.5 mm, glabrous, edges noticeably paler than bright green centre. *Petals* entire, carnose at apices, narrowly linear, 5.5–10.0 × 0.5–1.0 mm, creamy white with a green centre; *lip* divided into (3–)5–8 short, broad, obtuse, carnose lobes, long and narrow, 5.5–9.0 × 4.5–9.0, cream with green veins. *Spur* broadly conical, straight or slightly curved, 1.5–5.5 mm long. *Anther sacs* yellow. Figure 1A–E.

H. pilosa occurs in the southern Cape region (Figure 2) from Bredasdorp (Western Cape) to Port Elizabeth (Eastern Cape), and grows in semi-arid, stony localities. Flowering time: November to March.

The long, linear petals and long narrow lip, which together form a narrow cylindrical tube, are characteristic of this species. The inflorescence is strictly secund.

Vouchers: *Linder 1704* (BOL); *Long 938* (PRE); *Muir 1225* (BOL); *Thode A26392* (PRE).

2. **Holothrix longicornu** *G.J.Lewis* in Journal of South African Botany 4: 53 (1938); J.L.Stewart et al.: 60 (1982). Type: Port Elizabeth, *Cutting 69* (BOL, holo.!). Figures 2; 8N.

Leaves with dense, short, fine, retrorse hairs. *Scape* without bracts, 65–154 mm long, with dense, short, re-

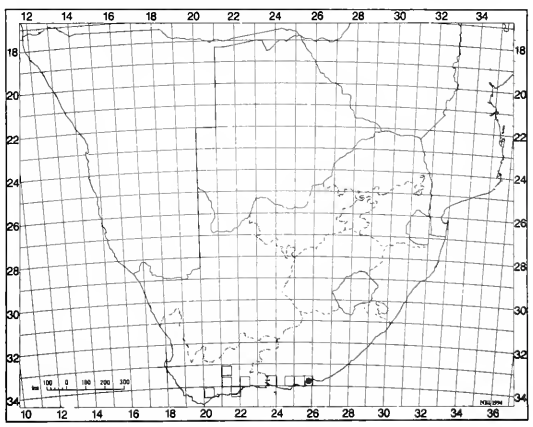

FIGURE 2.—Distribution of *Holothrix pilosa*, □; *H. longicornu*, ●.

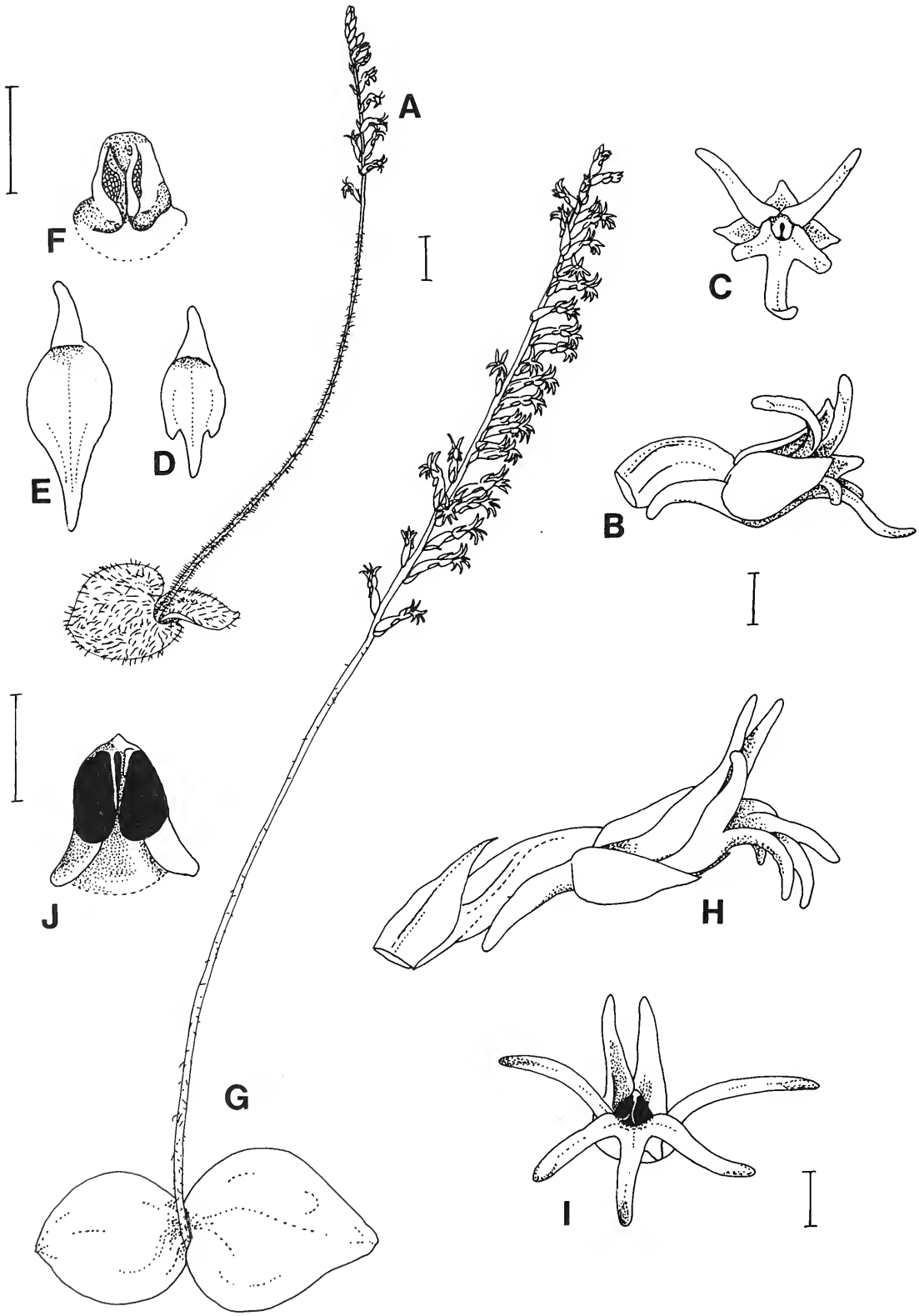

FIGURE 3.—A–F, *Holothrix exilis*: A, habit; B, flower, side view; C, flower, front view; D, lip with short side lobes, *Esterhuysen 21205*; E, lip without side lobes, *Esterhuysen 18356*; F, column. G–J, *H. secunda, Schelpe 7900*: G, habit; H, flower, side view; I, flower, front view; J, column. Drawn by K. Immelman. Scale bars: A, G, 10 mm; B–F, H–J, 1 mm.

curved hairs. *Sepals* 1.5–2.5 × 1.0 mm, glabrous, connate at base. *Petals* entire, carnose at apices, 2.5–3.5 × 0.5 mm; *lip* carnose, divided into 3–5 short, broadly linear lobes, 2.5–3.0 × 1.0–1.5 mm. *Spur* narrowly conical, straight, longer than lip, 3–4 mm long.

Holothrix longicornu is probably closely related to *H. cernua* (No. 5) and *H. brevipetala* (No. 4), all three species having recurved, hispid hairs on the scape. However, the short lip lobes (Figure 8N) distinguish it from the former, and the long, straight spur distinguishes it from both. Only the type has been seen but, as there are a number of plants in the type gathering, and they consistently show these characters, it can be regarded as a species separate from both the above-mentioned species.

Voucher: the only specimen of this species is the type, which was collected in October. The habitat is not known.

3. **Holothrix exilis** *Lindl.*, The genera and species of orchidaceous plants: 283 (1835); Immelman: 456 (1981); J.L.Stewart et al.: 59, t. 1.1 (1982). Type: in a walk to the white clay pit, bearing true N-E from our station at Zoetmelksrivier, *Burchell 6738-1* (K!).

H. exilis var. *brachylabris* (Sond.) Bolus: t. 14A (1896). *H. brachylabris* Sond.: 78 (1847). Type: Uitenhage, *Zeyher s.n.* (K!)

Leaves densely to very sparsely pilose with long, fine hairs, small, sometimes withered at anthesis. *Scape* without bracts, slender, 40–290 mm long, densely to very sparsely pilose with long, fine hairs at right angles to scape. *Inflorescence* usually lax with small flowers. *Sepals* 0.8–2.5 × 0.5–1.0 mm, usually glabrous or with a few long hairs. *Petals* entire, with carnose apices, 1.5–4.0 × 0.3–1.0 mm, creamy green; *lip* carnose, entire or three-lobed with outer lobes from very short to half as long as central lobe, 1.8–3.5 × 0.5–1.5 mm, creamy green. *Spur* slightly curved, 0.8–1.8 mm. *Anther sacs* pale yellow-green. Figure 3A–F.

H. exilis occurs in the coastal regions of the Western and Eastern Cape from the Saldanha area, the Cape Peninsula and Riversdale to Kei Mouth (Figure 4). Flowering time: October to March.

H. exilis can be distinguished from *H. villosa* (No. 6) by the side lobes of the lips which are up to 0.4 times the length of the central lobe, or absent, while *H. villosa* has side lobes (always present) from 0.6 to 1.0 times the length of the central lobe.

The variety *H. exilis* var. *brachylabris* was described by Bolus on the basis of an unlobed rather than a three-lobed lip. However, the length of the side lobes varies in a continuous rather than disjunct manner in the species, from scarcely discernable to well defined. The variety is therefore not upheld.

Vouchers: *Flanagan 1298* (PRE); *Glass 6237* (BOL); *Hall 1162* (BOL); *Jeppe s.n* (PRE).

4. **Holothrix brevipetala** *Immelman & Schelpe* in Immelman in Bothalia 13: 455 (1981); J.L.Stewart et al.: 60 (1982). Type: Humansdorp, koppie above Oudebos, *Jeppe in PRE 33391* (PRE, holo.!; K, iso.!).

H. parvifolia Lindl.: 283 (1835), partly as to part of description (see also *H. cernua*, No. 5), non *H. parvifolia* Lindl. (1836) which is *H. villosa* (No. 6).

Holothrix hispidula sensu Schltr.: 443 (1898); Bolus: t. 17 (1913); Bolus: t. 13 (1918) all excl. syn. L.f. (1782) and Thunb. (1794, 1823), non (L.f.) T.Durand & Schinz which is *H. cernua* (No. 5).

Leaves densely covered with small squamules or stout hairs, sometimes withered at anthesis. *Scape* without bracts, stout, 60–310 mm long, with stout, hispid, reflexed hairs. *Sepals* 1.0–2.5 mm, densely pilose. *Petals* entire, carnose at apices, 2.5–3.5 × 0.5–1.5 mm, yellow-green; *lip* and petals sometimes warty, lip carnose, oval in outline with 3–5 short, broad lobes (Figure 8Q), 2.5–3.5 × 2.0–3.5 mm, yellow-green. *Spur* slightly curved, 1.0–2.0 mm.

H. brevipetala occurs in the Western and Eastern Cape (Figure 4). It grows in sand and shallow soil in rock crevices. Flowering time: can be found in flower from August to April, usually between October and January.

The squamules or stout hairs on the leaves of this species, and the reflexed hairs on the scape, are similar to those of *H. cernua*. However, the lip lobes are much shorter and relatively broader than the linear lobes of *H. cernua*.

Vouchers: *Bruyns 141/75* (PRE); *Glass s.n.* (34859 in PRE); *Schlechter 464* (BOL); *Wolley Dod 2339* (BOL).

5. **Holothrix cernua** *(Burm.f.) Schelpe* in Orchid Review 74: 394 (1966); Immelman: 456 (1981); J.L.Stewart et al.: 60, t. 1.13 on p. 63 [not t. 1.13 on p. 62 which is *H. secunda* (No. 9)]. Type: Cap. bon. spei, *Burmann f. s.n.* (G!).

Orchis cernua Burm.f.: 30 ('26') (1768).

Orchis hispidula L.f.: 401 (1782). *Holothrix hispidula* (L.f.) T.Durand & Schinz: 5: 70 (1895) Type: Cape of Good Hope, *Sparrman 34* (LINN, microfiche in PRE!).

Orchis hispida Thunb.: 4 (1794); Thunb.: 6 (1823). *H. parvifolia* Lindl.: 283 (1835) partly excl. part of description which fits *H. brevipetala* (No. 4). Lectotype: C.B.S., in arenosis depressis extra Cap, in summitate Taffelberg (sic!) et rupibus lateris occidentalis ejusdem montis, *Thunberg* α (UPS, microfiche No. 21201 at PRE!).

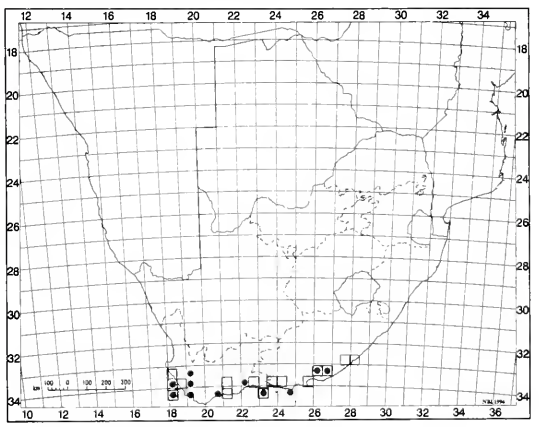

FIGURE 4.—Distribution of *Holothrix exilis*, □; and *H. brevipetala*, ●.

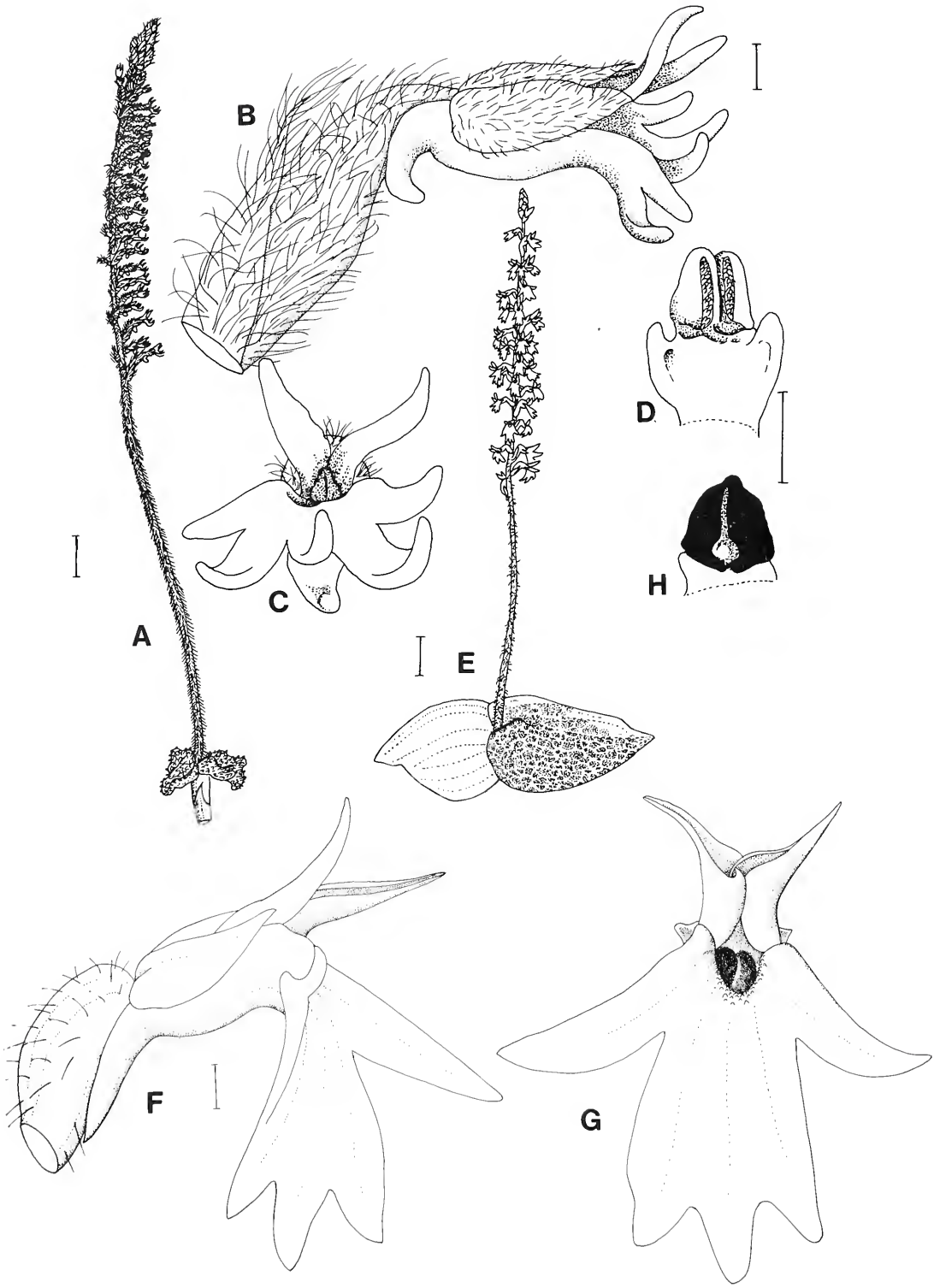

FIGURE 5.—A–D, *Holothrix cernua, Linder 1792*: A, habit; B, flower, side view; C, flower, front view; D, column. E–H, *H. orthoceras, Royal Natal National Park s.n.*: E, habit; F, flower, side view; G, flower, front view; H, column. A–E, H, drawn by K. Immelman; F, G, drawn by G. Condy. Scale bars: A, E, 10 mm; B–D, F–H, 1 mm.

Monotris secunda Lindl.: 303 (1835) non *Orchis secunda* Thunb. *H. monotris* (Lindl.) Rchb.f.: 119 (1881). Type: between Mossel Bay and Gouritz River, *Burchell 6369* (K!).

H. gracilis Lindl.: 207 (1836); Bolus: 116 (1888). Type: Table Mountain, *Drège 1253a* (P!).

H. harveyana Lindl.: 206 (1836); Hook.f.: 103 A (1837). Type: Cape Peninsula, low sandy moist plains, called 'The Flats' which extend almost from Table Bay to False Bay (Cape Flats), *Harvey s.n.* (TCD!).

H. squamulosa Lindl.: 206 (1836); Bolus: t. 18 (1913), t. 11 (1918). *H. squamulosa* var. *typica* Schltr.: 442 (1898). Type: Cape Province, mountains near De Liefde, Koratra, *Drège 1235c* (K!).

H. squamulosa var. *hirsuta* Bolus: 236 (1888). Type: Cape Peninsula, moist sandy places on Cape Flats, especially after burning; sometimes on old thatched roofs near Rondebosch, *Bolus 7022b* (BOL!; K!).

H. squamulosa var. *scabra* Bolus: 114, t. 23a (1888). Type: Cape Peninsula, moist sandy places on Cape Flats, especially after burning; sometimes on old thatched roofs near Rondebosch, *Bolus 7022a* (BOL!).

H. squamulosa var. *glabrata* Bolus: t. 18 (1913). Type: Cape Peninsula, moist sandy places on Cape Flats, especially after burning; sometimes on old thatched roofs near Rondebosch, *Bolus 7022c* (BOL!; K!).

Leaves with a dense covering of squamules or small, stiff hairs, rarely glabrous with hairs on the margins only, sometimes withered before anthesis. *Scape* without bracts, slender or stout, 90–240 mm long, with long, hispid, deflexed hairs. *Sepals* 1.5–3.0 × 0.5–1.5 mm, densely hirsute. *Petals* entire, carnose at apices, 3.5–7.0 × 0.5–1.5 mm, cream to lime-green; *lip* carnose with 3–5 or (6 or 7) lobes (Figure 8D), central lobe the longest, lobes comprising $^1/_3$ to $^1/_2$ the length of whole lip, colour as for petals. *Spur* curved, 1.5–4.0 mm long. *Anther sacs* chestnut-brown (Figure 5A–D).

H. cernua is found mainly in the Western Cape, from the Gifberg to the George area, but extends also along the southern Cape lowland as far east as Grahamstown in the Eastern Cape (Figure 6). It grows in sandy or stony places, often flowering after fire. Flowering time: July to January.

Vouchers: *Bolus 11383* (BOL); *Galpin 4587* (PRE); *Hall 1107* (BOL); *Oliver 4587* (PRE).

6. **Holothrix villosa** *Lindl.* in Hooker's Companion to the Botanical Magazine 2: 207 (1836).

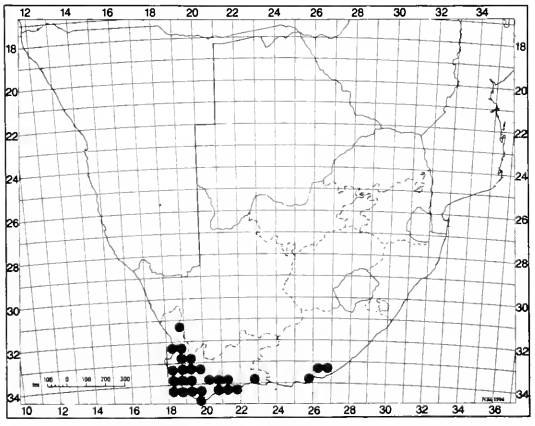

FIGURE 6.—Distribution of *Holothrix cernua.*

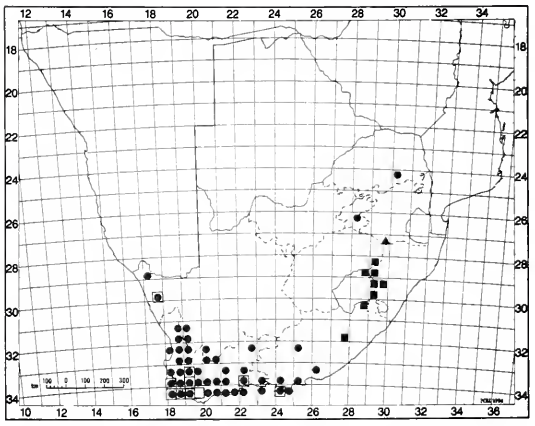

FIGURE 7.—Distribution of *Holothrix villosa* var. *villosa*, ●; *H. villosa* var. *condensata*, □; *H. majubensis*, ▲; and *H. thodei*, ■.

The species is divided into two varieties: var. *condensata* is generally shorter and stouter, with a denser inflorescence and broader lip lobes than var. *villosa*.

6a. var. **villosa**

Bolus: t. 14b (1896), Bolus: t. 14B (1918); Immelman: 456 (1981); J.L.Stewart et al.: 61, t. 1.9a (1982). Type: Groot Drakenstein and at the foot of Paarl Mountain, under 1000 ft, *Drège 1235a* (K!).

Orchis hispida Thunb.: 4 (1794); Thunb.: 6 (1823) p.p. quoad spec. *Thunberg* β (UPS, microfiche no. 21202 at PRE!).

H. parvifolia Lindl.: 207 (1836) non *H. parvifolia* Lindl. (1835) see *H. brevipetala* (No.4) and *H. cernua* (No. 5); Hook.f.: 103B (1837). Type: about Cape Town and Wynberg, in the driest and most barren hills and wastes in a stony and gravelly soil, *Harvey s.n.* (TCD?).

Leaves with few to many long, straight hairs. *Scape* without bracts, 30–365 mm long, densely to sparsely pilose with long, straight hairs at right angles to scape. *Sepals* 1.0–2.5 × 0.5–1.5 mm, glabrous or with short, straight hairs. *Petals* entire, carnose at apices, 1.5–4.5 × 0.5–1.5 mm, cream to yellow-green; *lip* carnose, divided into three subequal lobes, 1.4–4.0 × 0.5–3.0 mm. *Spur* broadly conical, curved, 2.0–5.5 mm long. *Column* green. *Anther sacs* yellow-green. Figure 1F–J.

H. villosa is probably the commonest species of *Holothrix* in southern Africa, as well as the most widespread. The typical variety occurs in western Northern Cape and throughout the Western Cape, and in the western part of Eastern Cape (Figure 7). It has recently been found (disjunctly) as far north as Gauteng (Johannesburg) and the Northern Province. It grows in rock crevices and in fynbos on hillsides. Flowering time: August to December.

The 3-lobed lip and patent hairs on the scape will distinguish *H. villosa* from the occasional specimens of *H. cernua* (No. 5) which do not have squamules on the leaves.

Vouchers: *Bolus 11638* (BOL); *Esterhuysen 22291* (BOL); *Galpin 4588* (PRE); *Leistner 435* (PRE); *Oliver 5058* (PRE); *Venter 10276* (PRE).

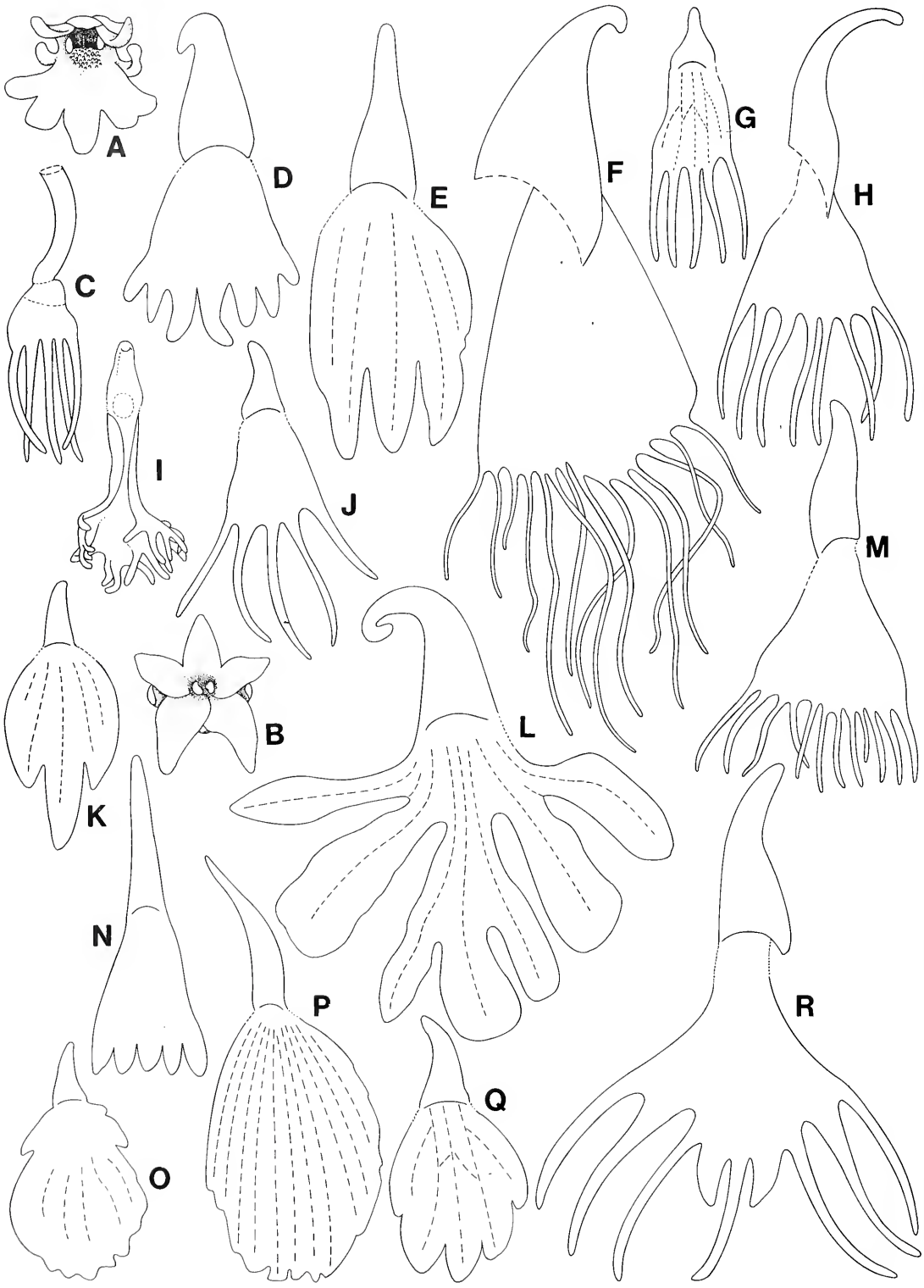

FIGURE 8.—A, B, flowers of *Holothrix*: A, *H. mundii, A. Bean s.n.*, front view; B, *H. majubensis*, front view. C–R, comparison of lip shape (not drawn to scale): C, *H. filicornis, Van der Westhuizen s.n.* (only part of spur shown); D, *H. cernua, Bolus 7022*; E, *H. villosa* var. *condensata, Esterhuysen 29418*; F, *H. randii, McLoughlin s.n.*; G, *H. micrantha, Mottley 2051*; H, *H. schlechteriana, Glass 423*; I, *H. grandiflora, Bruyns 34/76*; J, *H. incurva, Compton 21434*; K, *H. thodei, Wood 5574*; L, *H. parviflora, Gordon s.n.*; M, R, *H. scopularia, Linder 1031*; N, *H. longicornu, Cutting 69*; O, *H. culveri, Culver 84*; P, *H. macowaniana, Scully 6204*; Q, *H. brevipetala, Schelpe s.n.* Drawn by G. Condy.

6b. var. **condensata** *(Sond.) Immelman* in Bothalia 13: 456 (1981); J.L.Stewart et al.: 61, t. 1.9b (1982). Type: Swellendam, in sand dunes, *Mund s.n.* (K, lecto.!).

H. condensata Sond.: 76 (1847), Bolus: 36 (1911), Bolus: t. 12 (1918).

H. lithophila Schltr.: 446 (1898). Type: in rock crevices on mountain above Vogelgat lagoon, *Schlechter 9556* (B†, one flower at K!).

Leaves often broader than long, slightly to densely pilose with long, fine hairs. *Scape* 85–240 mm long, with long fine hairs at right angles to scape, without bracts, usually stout with inflorescence dense. *Sepals* 1.5–3.5 × 1.0–2.5 mm, glabrous to fairly densely pilose with short, fine hairs, broad, often more than half the length of petals. *Petals* entire, carnose, 3.5–7.0 × 1.5 mm, green or yellowish green; *lip* carnose, with three broadly linear lobes $^1/_3$ to $^1/_2$ length of lip (Figure 8E), lip 3.5–6.5 × 1.5–3.5 mm. *Spur* broadly conical, curved, 2.0–5.5 mm long.

H. villosa var. *condensata* has been found in the western Northern Cape, the southern Western Cape, and as far east as Humansdorp in the southern Eastern Cape (Figure 7). It grows in moist areas, and is either lithophytic or grows in shallow soil in rock crevices. Flowering time: October to January.

Vouchers: *Andreae 843* (PRE); *Esterhuysen s.n.* (BOL); *Leighton 748* (BOL); *Pillans 3508* (PRE).

7. **Holothrix majubensis** *C.Archer & R.H.Archer* in South African Journal of Botany 62: 209–211 (1996). Type: KwaZulu-Natal, Newcastle Dist., Majuba Mtn, sandstone cliffs on northern slopes near summit, ± 2 225 m (2729BD), 7 Jan. 1995, *C. Archer & R.H. Archer 2063* (PRE, holo.!; BOL!, NH!).

Leaves, up to 35 × 25 mm, fairly thick-textured, thinly woolly on margin only. *Scape* without bracts, up to 55 mm long, with dense to sparse white, woolly hairs. *Inflorescence* dense, secund; flowers non-resupinate. *Sepals* ± 2.0 × 1.2 mm, broadly ovate, sparsely hairy. *Petals* entire, carnose, ± 2.8 × 1.0 mm, white; *lip* with undivided portion 1.5 × 2.0 mm, white (Figure 8B); lobes 3, ± equal, 1.0 × 0.6 mm. *Spur* conical, slightly recurved, 1 mm long.

To date the new species is known only from the type locality (Figure 7), where it is fairly plentiful. Archer & Archer (1996) expect that it will be found on similar northern faces of neighbouring mountains in northern KwaZulu-Natal and southern Mpumalanga. Its habitat is rather vulnerable to erosion since the plants grow in exposed soil in cracks in vertical sandstone cliffs. Flowering time: December and January.

The species is well distinct from all other known species by its non-resupinate flowers.

In the genus, the non-resupinate flowers of *Holothrix majubensis* are the main distinguishing character. It is postulated that the non-resupination is an adaptation to the pollinator: due to the inflorescences arching outwards and downwards, the flowers are placed in the correct position for pollination. Non-resupinate flowers are also known in the unrelated *Habenaria* Willd.

8. **Holothrix thodei** *Rolfe* in Dyer, Flora capensis 5,3: 100 (1912); J.L.Stewart et al.: 60 (1982). Type: [Orange] Free State, Witsieshoek, summit of QuaQua Mountains in stony and grassy places, 7500 ft, *Thode 48* (BOL!).

Leaves with a dense covering of small, stout, squamous hairs, withered at anthesis. *Scape* without bracts, 100–240 mm long, densely covered with stout, scabrid, reflexed hairs. *Sepals* 1.5–3.5 × 0.5–1.0 mm, with dense short hairs, usually connate. *Petals* entire, carnose, 3.5–5.0 × 0.5–1.5 mm, yellow or yellow-green; *lip* carnose, with three lobes (Figure 8K), outer pair of lobes $^1/_5$–$^1/_2$ the length of central lobe, 2.5–4.5 × 1.5–3.5 mm, colour as for petals. *Spur* slightly curved, 0.5–2.5 mm.

This montane species occurs in Lesotho and the Drakensberg of the Free State and KwaZulu-Natal, with one record from near Engcobo, Eastern Cape (Figure 7). It is recorded from basalt-derived soils in rocky grasslands or crevices in rocks. Flowering time: January and February.

Although it has a flower very similar to *H. exilis* (No. 3), *H. thodei* has thick, scabrid hairs (squamules) on the scape like those of *H. cernua*. It also has a completely different distribution.

Vouchers: *Jacobs s.n.* (BOL); *Jacot Guillarmod, Getliffe & Mzamane 32* (PRE); *Killick 1304* (PRE); *Schelpe 297* (BOL); *Trauseld 961* (NU).

9. **Holothrix secunda** *(Thunb.) Rchb.f.* in Otia botanica hamburgensia 2: 119 (1881); Bolus: t. 37 (1911); J.L.Stewart et al.: 62, t. 1.13 on p. 62 [not 1.13 on p. 63 which is *H. cernua* (No. 5)] (1982). Type: *Thunberg s.n.* (UPS, holo., microfiche no. 21243 at PRE!).

Orchis secunda Thunb.: 4 (1797); Thunb.: 6 (1823).

Tryphia major Sond.: 82 (1847). Type: Brakfontein, 2000–4000 ft, *Zeyher s.n.* (K!).

Leaves glabrous, succulent. *Scape* without bracts, 45–300 mm long, slightly to densely pilose with short, fine hairs. *Inflorescence* subsecund. *Sepals* 1.5–3.5 × 1.0–2.0 mm, glabrous. *Petals* entire, carnose, adnate to lip at their bases, 2.5–7.0 × 0.5–2.0 mm, creamy white to yellowish to yellow-green; *lip* carnose, divided into five subequal lobes, lobes linear, lip with a few papillae at entrance to spur, 3.5–8.5 × 1.5–4.0 mm, colour as for petals. *Spur* slightly curved, 1.5–4.5 mm. *Column* cream and lime-green. *Anther sacs* deep reddish mauve. Figure 3G–J.

H. secunda is mainly distributed in the western Northern Cape and in Western Cape, with a few records from Eastern Cape (Figure 9). It does not, however, occur on the Cape Peninsula. It grows in dry areas in the shade of bushes, on stony soil, in rock crevices and on ledges. Flowering time: June to October.

The glabrous leaves, and the petals, which are adnate to the lip at their bases, will distinguish this species from others having a 5-lobed lip and carnose petals. Thunberg did not designate a type, but there is only one specimen

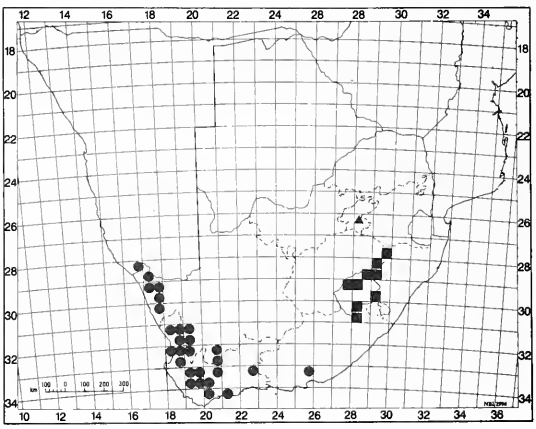

FIGURE 9.—Distribution of *Holothrix secunda*, ●; *H. incurva*, ■; and *H. micrantha*, ▲.

of this species at UPS (21243 on microfiche), which fits his description and is annotated in his hand.

Vouchers: *Acocks 17725* (PRE); *Bruyns 1132* (BOL); *Compton 4329* (BOL); *Muir 2764* (PRE).

10. **Holothrix incurva** *Lindl.* in Hooker's Companion to the Botanical Magazine 2: 207 (1836); Immelman: 456 (1981); J.L.Stewart et al.: 62 (1982). Type: Stockenstrom Div., Katberg, *Drège 8275a* (K!).

H. rupicola Schltr.: 419 (1898); Bolus: t. 40B (1911). Syntypes: Mont-aux-Sources, summit, in fissures of rocks, *Thode 6* (not found); slopes of Mont-aux-Sources, 8000–9000 ft, *Flanagan 11981* (BOL!).

Leaves glabrous or with a few short, scattered hairs, margins with a dense fringe of short hairs. *Scape* 72–170 mm long, densely villous with short, fine hairs at right angles to the scape, without bracts. *Sepals* 2.0–4.5 × 1.5–2.0 mm, densely villous with fine short hairs. *Petals* entire, with carnose, much-attenuated apices, 5.0–9.5 × 1.5–1.0 mm, yellow or greenish yellow; *lip* carnose, with 5 linear lobes (Figure 8J), 3.5–4.5 × 1.5–2.0 mm, yellow or greenish yellow. *Spur* broadly conical, curved, 1.0–1.5 mm long.

This montane species is distributed in the high-lying areas of the Eastern Cape, KwaZulu-Natal, the Free State and Lesotho (Figure 9), and grows on basalt ledges and rocky crevices. Flowering time: December to April.

Vouchers: *Hilliard & Burtt 9803* (NU); *Prescott s.n.* (BOL); *Schelpe 7677* (BOL); *Stewart 1947* (NU).

11. **Holothrix micrantha** *Schltr.* in Botanische Jahrbücher 20, Beihefte 50: 31 (1895); J.L.Stewart et al.: 61 (1982). Type: mountains above Heidelberg, on grassy cliffs, 5400 ft, *Schlechter 3522* (B†).

Leaves pilose, withered at anthesis. *Scape* without bracts, 72–170 mm long, with long, straight hairs. *Sepals* 1.5–2.0 × 0.5–1.0 mm, with a few hairs at apices. *Petals* entire, with carnose apices, 3.0–4.5 × 0.5–1.0 mm; *lip* carnose, divided into five linear, acute lobes (Figure 8G), 3.5–4.5 × 1.5–2.0 mm. *Spur* broadly conical, curved, 1.0–1.5 mm long.

The type, collected at Heidelberg in Gauteng, was not seen; it was probably destroyed in Berlin. Three other specimens exist which match the description of *H. micrantha*: two from Killarney near Johannesburg (PRE!, J!) the J specimen from a marsh (Figure 9), and one from Modderfontein (K!). The description is taken from the Killarney specimen. Flowering time: September and October.

This rare species is very similar to *H. incurva* (No. 10) but is smaller, has a slightly denser spike, and a different distribution and flowering time. When more specimens are found, it may prove to be only a variant of that montane species.

Voucher: *Mottley 2015* (J).

12. **Holothrix filicornis** *Immelman & Schelpe* in Immelman in Bothalia 13: 455 (1981); J.L.Stewart et al.: 64, t. 1.16 (1982). Type: Namaqualand, 23 km west of Springbok, *Acocks 19269* (BOL, holo.!; PRE!, K!).

Leaves glabrous, large. *Scape* without bracts, 65–260 mm long, glabrous. *Sepals* ovate, acute, 1.5–2.0 × 0.5–1.0 mm, glabrous, green tinged with red. *Petals* with three filiform lobes $^1/_2$–$^2/_3$ as long as petals; petals 3.0–8.0 × 0.5–1.0 mm, greenish white; *lip* 4.5–9.0 × 1.5–2.5 mm, greenish white, divided into five filiform lobes (Figure 8C), lobes comprising $^2/_3$–$^3/_4$ of total lip length. *Spur* slightly curved and pendulous, 1.25–2.0 times length of lip, 7–11 mm long. *Ovary* twisted, green tinged with red.

H. filicornis occurs in northern Namaqualand (Northern Province), growing in the shelter of rocks and shrubs on mountainsides (Figure 10). Flowering time: June to September.

This species, together with the montane *H. scopularia* (No. 13), is unusual among the species of South African *Holothrix* in having divided petals, but no bracts on the scape. The two species always have three-lobed petals, instead of the variable number of petal lobes of the other species with divided petals and a bracteate scope. The extremely long spur, the different distribution and habitat, and the less strongly secund spike of *H. filicornis*, how-

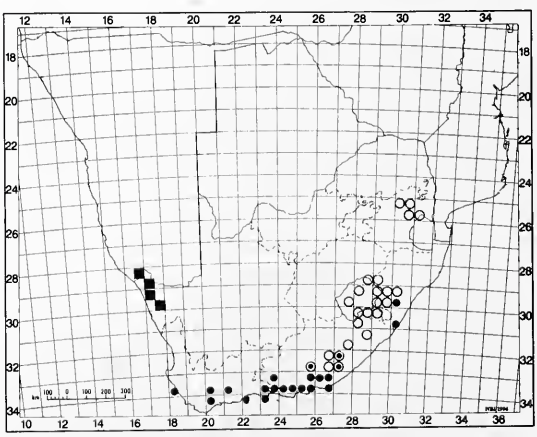

FIGURE 10.—Distribution of *Holothrix filicornis*, ■; *H. scopularia*, ○; and *H. parviflora*, ●.

ever, make it easy to distinguish this species from *H. scopularia*.

Vouchers: *Oliver, Tölken & Venter 652, 702, 823* (PRE); *Tölken 3293* (BOL); *Van der Westhuizen s.n.* (in liquid preservative in BOL, labelled H.M.F. 20 and 21); *Williamson 2562, 2565* (BOL).

13. **Holothrix scopularia** *(Lindl.) Rchb.f.*, in Otia botanica hamburgensia 2: 119 (1881); Schltr.: 21 (1899a) partly, excl. *H. pleistodactyla*; Bolus: 38 (1911); Immelman: 456 (1981); J.L.Stewart et al.: 64, t. 1.17 (1982). Type: Witbergen summit, 6000 ft, *Drège 8275b* (K! lecto., here designated; P!).

Scopularia secunda Lindl.: 207 (1836) non *Orchis secunda* Thunb. (1823).

H. multisecta Bolus: 170, 190, t. 7 (1890); T.Durand & Schinz: 71 (1895), as *H. multiseta*. Type: Stockenstrom, Elandsberg summit, *Scully 391* (K!, BOL!).

H. burchellii sensu Kraenzl.: 589 (1899) non Lindl. (1835).

Leaves moderately to densely pilose with long, straight, slender hairs, often withered at anthesis. *Scape* without bracts, 110–340 mm long, densely pilose with long, straight, slender hairs at right angles to scape. *Inflorescence* strongly secund. *Sepals* 1.5–4.0 × 1.0–2.0 mm, glabrous or with a few long hairs. *Petals* three-lobed, 3.0–11.0 × 0.5–2.5 mm, cream or pinkish cream, sometimes wine-coloured; *lip* 5–12-lobed (Figure 8M, R), 2.0–13.0 × 1.5–4.5 mm, colour as for petals. *Spur* curved, 1.0–4.5 mm long.

H. scopularia occurs in the high mountain areas of the Eastern Cape, KwaZulu-Natal and Lesotho, and also (disjunctly) in Mpumalanga (Figure 10). It grows on grassy slopes and rocky outcrops, and flowers from September to January.

Vouchers: *Dieterlen 1301* (PRE); *Galpin s.n.* (BOL); *Schelpe 7159* (BOL); *Sim 1267* (PRE); *Stewart 1825* (NU).

14. **Holothrix parviflora** *(Lindl.) Rchb.f.*, Otia botanica hamburgensia: 119 (1881); Immelman: 456 (1981); J.L.Stewart et al.: 63 (1982). Type: Swanepoelspoort Mountains, 3000–4000 ft, *Drège 8276a* (K!).

Tryphia parviflora Lindl.: 209 (1836). *H. lindleyana* var. *parviflora* (Lindl.) Rolfe: 106 (1912).

T. secunda Lindl.: 209 (1836) non *Orchis secunda* Thunb. (1823). *H. lindleyana* Rchb.f.: 119 (1881); Bolus: t. 35 (1911). Type: Koratra (Karatara?), *Drège s.n.* (K!).

Leaves glabrous, succulent. *Scape* without bracts, 70–240 mm high, glabrous. *Sepals* 1.5–3.5 × 0.5–1.5 mm, glabrous. *Petals* entire, membranous in texture, adnate to lip at base, 3.0–6.5 × 0.5–1.5 mm, pure white or flushed with purple at base; *lip* 3.5–9.0 × 0.5–1.5 mm (breadth taken at base of three central lobes), pure white or with pale purple lines and throat, membranous, divided into five lobes, the outer pair of lobes broadly linear, inner three shorter, broadly linear to nearly rectangular (Figure 8L). *Spur* narrowly conical, circinnate, 1.5–5.5 mm long.

H. parviflora occurs from around the Cape Peninsula (Western Cape) to Stutterheim (Eastern Cape), then (disjunctly) in southern KwaZulu-Natal (Figure 10). It grows in damp places and on mossy boulders, usually in a sheltered position or under bushes and trees, and has also been recorded from rocks just above high tide (at Knysna). Flowering time: July to November.

The circinnate spur and the petals which are basally adnate to the lip, are characteristic of this species.

Vouchers: *Bayliss 35/1562* (PRE); *Long 1018* (PRE); *McLoughlin s.n.* (BOL); *Parker 1059* (BOL); *Sim 950* (NU).

15. **Holothrix orthoceras** *(Harv.) Rchb.f.*, Otia botanica hamburgensia: 119 (1881); Bolus: t. 23 (1911); J.L.Stewart et al.: 62, t. 1.11 (1982). Type: Howieson's Poort, and on the Katberg, *Hutton s.n.* (TCD!, lecto., here designated; K!).

Tryphia orthoceras Harv.: 4, t. 105 (1863).

Leaves glabrous, reticulated with white or silver. *Scape* without bracts, 60–280 mm long, densely pilose with fine, short hairs. *Sepals* 1.5–3.5 × 0.5–1.0 mm, glabrous. *Petals* entire, membranous, base of each petal rolled into a tube with its edge hooked into edge of opposite petal, 3.5–7.5 × 1.0–2.0 mm, white, apices attenuate; *lip* papillate at entrance to spur, 4.0–8.5 × 2.0–5.5 mm, white with or without purple veins, membranous, divided into five to many lobes, outer pair of lobes broadly linear and acute, two or more times as long as triangular central lobes. *Spur* acute, straight, 2.5–6.5 mm long. *Anther sacs* purple. Figure 5E–H.

This fairly common species occurs in forests in the Eastern Cape, KwaZulu-Natal, Mpumalanga and the Northern Province (Figure 11). Flowering time: March to May, but also occasionally in October and November.

H. orthoceras is similar to the rarer *H. macowaniana* (No. 18) but differs in having silver-veined leaves and a longer outer pair of lobes on the lip. It is also often confused with *H. parviflora*, but its straight spur, and the triangular rather than rectangular lobes in the centre of the lip, will distinguish it.

Vouchers: *Allsop s.n.* (PRE); *Bokelmann s.n.* (PRE); *Botha s.n.* (PRE); *Hilliard & Burtt 6519* (NU); *McLoughlin 626* (BOL).

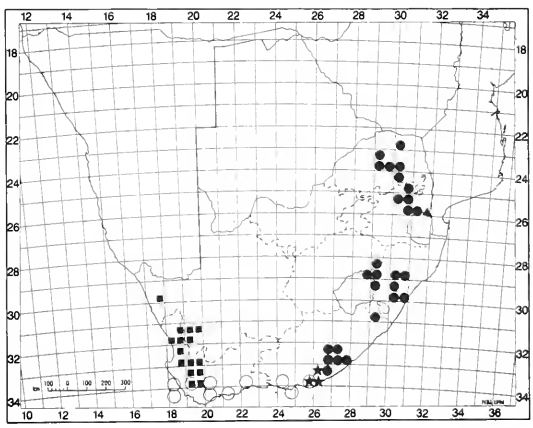

FIGURE 11.—Distribution of *Holothrix orthoceras*, ●; *H. aspera*, ■; *H. mundii*, ○; *H. macowaniana*, ★; and *H. culveri*, ▲.

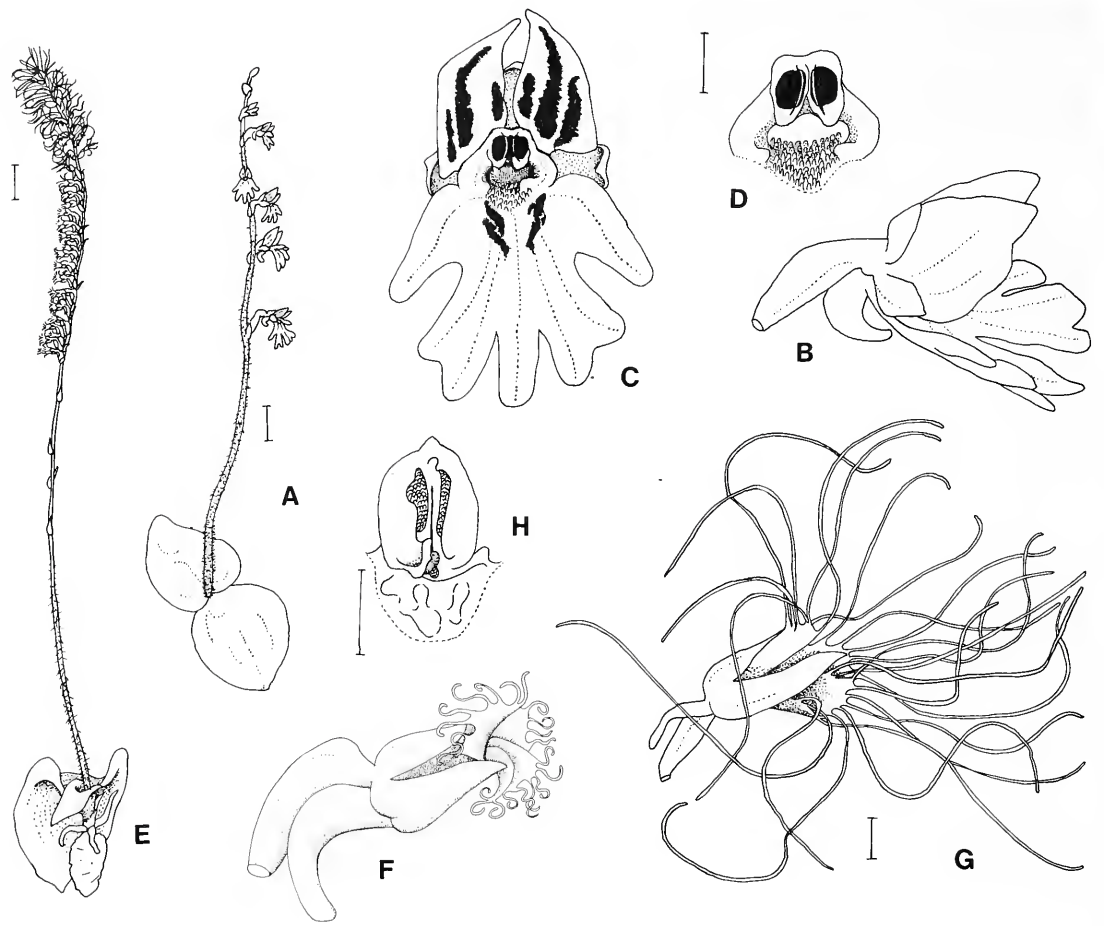

FIGURE 12.—A–D, *Holothrix aspera, Schelpe s.n.*: A, habit; B, flower, side view; C, flower, front view; D, column, front view. E–H, *H. burchellii*: E, habit, *A. Bean 142*; F, flower from base of spike, *Seagrief s.n.*; G, flower, 3/4 way up spike, *Seagrief s.n.*; H, column, front view. Drawn by K. Immelman. Scale bars: A, E, 10 mm; B–D, F–H, 1 mm.

16. **Holothrix mundii** *Sond.* in Linnaea 19: 77 (1847); Bolus: t. 13 (1896); Bolus: t. 10 (1918); J.L.Stewart et al.: 60, t. 1.2 (1982). Sytnypes: Swellendam area, *Mund s.n.* (K!), and in Worcester area, Winterhoekberge, 4000–5000 ft, among ericas, *Zeyher s.n.*

Leaves glabrous, small. *Scape* without bracts, 60–160 mm long, with short, fine, slightly reflexed hairs. *Inflorescence* condensed (Figure 8A). *Sepals* 1.0–2.0 × 0.3–0.5 mm, glabrous. *Petals* entire, membranous, 1.5–2.5 × 0.3–0.5 mm, white; *lip* membranous, divided into seven lobes on the same pattern as *H. aspera* (central lobe and outer pair longer than other four lobes), papillate at entrance to spur, 1.5–3.5 × 0.5–2.0 mm, white. *Spur* straight, 0.5–1.5 mm long. *Column* very short, green. *Anther sacs* bright pinkish mauve.

H. mundii is distributed from the Cape Peninsula through the southern Western and Eastern Cape as far east as Port Elizabeth (Figure 11). Flowering time: September to November.

H. mundii is very similar to *H. aspera* (No. 17) in the shape of its lip, but can easily be distinguished by the condensed inflorescence, as well as by the smaller flowers and straight spur. It is one of the smallest species in southern Africa, and the only one with a condensed inflorescence.

Vouchers: *Bolus 4971* (PRE); *Esterhuysen 19033* (BOL); *Fair s.n.* (BOL); *Muir s.n* (PRE).

17. **Holothrix aspera** *(Lindl.) Rchb.f.*, Otia botanica hamburgensia: 119 (1881); Bolus: 19B (1913); Immelman: 456 (1981); J.L.Stewart et al.: 63, t. 1.15 (1982). Type: Namaqualand, between Mierenkasteel and Zwartdoornrivier (13 miles south of Garies), *Drège 8276b* (K!).

Bucculina aspera Lindl.: 209 (1836).

Holothrix confusa Rolfe: 105 (1912). Syntypes: mountainsides about Clanwilliam, *Leipoldt in MacOwan & Bolus s.n.* (Herb. Norm. Aust. 1757); stony places on Blaauberg, *Schlechter 8465* (K!, BOL!); near Oliphant's River Mountains, *Schlechter 5036* (K!); near Piekenierskloof and near Modderfontein, *Schlechter 5077*; Hex River Valley, *Wolley Dod 4054* (K!, BOL!).

Leaves glabrous. *Scape* without bracts, 30–250 mm long, nearly glabrous to moderately pubescent with short, fine hairs. *Sepals* 1.0–3.5 × 0.8–2.5 mm, glabrous. *Petals* entire, broad, membranous, 3.5–6.5 × 1.0–4.0 mm, white

with bright green bases and two broad maroon or purple stripes; *lip* membranous, divided into seven unequal lobes, usually densely papillate at throat, 3.0–8.5 × 1.0–6.0 mm, colour as for petals. *Spur* very broad, strongly curved and bent forward under lip, 2.0–5.0 mm long. *Column* arched over entrance to spur, lime-green. *Anther sacs* purple or maroon. Figure 12A–D.

A species of semi-arid areas, *H. aspera* occurs in the Western Cape and in southern Namaqualand, with one record from the Springbok District, Northern Cape (Figure 11). It is found in sandy or rocky ground or in crevices in rocks. Flowering time: June to October.

This species cannot be confused with any other from the Western Cape or the Namaqualand area. The column differs from the usual state in *Holothrix*, forming an open arch across the mouth of the spur. The lip is densely papillate under and in front of this arch. The attitude of the spur is also unique, being doubled up like a penknife under the spur (and also curved), rather than gently curved or circinnate as in other species.

Vouchers: *Acocks 17032* (PRE); *Bolus s.n.* (BOL); *Esterhuysen 3394a* (BOL), *5567* (PRE).

18. **Holothrix macowaniana** *Rchb.f.* in Otia botanica hamburgensia 2: 108 (1881). Type: Bedford Div., Kagaberg, *Weale s.n.*, sent by MacOwan (BOL, lecto.!; K!).

Leaves glabrous, small. *Scape* without bracts, 50–60 mm long, glabrous or with short, fine hairs at right angles to scape. *Sepals* 1.5–3.0 × 0.5 mm, glabrous. *Petals* entire, membranous, with attenuate apices, 3.0–4.5 × 0.5–1.5 mm, white; *lip* 5.5–6.5 × 2.5–5.5 mm, white, membranous, divided into very shallow, broad, triangular lobes, number of lobes indeterminate (Figure 8P). *Spur* narrowly conical, straight, 3.5–6.5 mm long.

This small and probably not very common species has a restricted distribution in the forests of the southern Eastern Cape (Figure 11). Flowering time: August to October.

Vouchers: *Glass 6204b* (BOL); *MacOwan s.n.* (BOL); *Scully s.n.* (*20503* in SAM).

19. **Holothrix culveri** *Bolus* in Transactions of the South African Philosophical Society 16: 147 (1905); Immelman: 456 (1981); J.L.Stewart et al.: 61 (1982). Type: near Barberton, Fig Tree Creek, on rocky slopes, 2000 ft, Sept. 1890, *Culver 84* (BOL!).

Deroemera culveri (Bolus) Schltr.: 144 (1907).

H. culveri var. *integra* Bolus: 147 (1905). Type: Barberton, *Culver 84a* (BOL!, K!).

Leaves withered at anthesis, apparently only one present. *Scape* with bracts, slender, ± 140 mm long, with a few short hairs at base. *Sepals* 2.5 × 0.8 mm, glabrous. *Petals* entire, membranous, oblong, 4.0 × 1.5 mm, white; *lip* membranous, entire or with small acute lobe on either side of broadly oval central limb (Figure 8O), 3.5 × 3.0 mm, white. *Spur* straight, acute, half as long as lip, 1.5 mm long.

Only the type specimen has ever been collected, from near Barberton, Mpumalanga (Figure 11), on rocky slopes at 2000 ft. Flowering time: September.

Voucher: type only.

H. culveri is unique among the southern African species of *Holothrix* in having bracts on the scape and entire, delicate petals. *H. squammata* (A.Rich.) Rchb.f. from Uganda and Ethiopia, however, has the same combination of characters. Bolus states that there were spurs on the side-sepals of *Culver 84a*, but this was not seen; possibly a strip of tissue was torn off the ovary when the sepals were dissected.

20. **Holothrix burchellii** *(Lindl.) Rchb.f.* in Otia botanica hamburgensia: 119 (1881); Bolus: t. 39 (1911); J.L.Stewart et al.: 66, t. 1.22 (1982). Type: Zoetmelks Rivier, *Burchell 6709* (K!).

Scopularia burchellii Lindl.: 304 (1835).

Leaves glabrous. *Scape* with bracts, 150–500 mm long, with short, deflexed hairs, stout. *Inflorescence* secund, with dimorphic flowers. *Sepals* 2.5–5.0 × 1.0–2.5 mm, glabrous. *Petals* divided at apex into 5–10 filiform lobes, longer on upper than lower flowers of spike, petals 3.5–18.0 × 1.0–3.5 mm, cream-coloured; *lip* 3.0–9.0 × 1.5–4.0 mm, cream-coloured, divided into 5–13 lobes, lobes longer on upper than on lower flowers of spike. *Spur* curved, smaller on upper than lower flowers, 3.0–6.0 mm long. *Anther sacs* pale chestnut to tan in colour. Figure 12E–H.

This species occurs in the Western Cape at Piketberg, and then at Bredasdorp and from there as far east as the Queenstown and Stutterheim Districts in Eastern Cape (Figure 13). Flowering time: August to November.

A striking feature of *H. burchellii* is the dimorphic flowers, the upper having greatly elongated petal and lip lobes compared to the lower. The spur and column of the upper flowers are smaller, but in the same proportion to the size of the flower (excluding the lobes of lip and petals) as in the lower flowers. The upper flowers are said to be sterile, but the author has seen them produce cap-

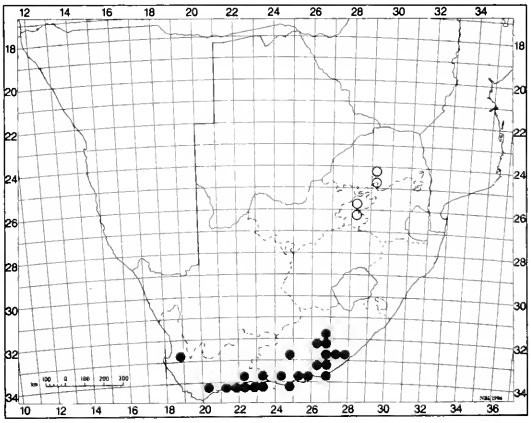

FIGURE 13.—Distribution of *Holothrix burchellii*, ●; and *H. randii*, ○.

sules with seed in them, and the column and pollinia are no different in structure from those of the lower flowers.

Also, although the flowers are generally described as 'dimorphic' this is not strictly correct, as the transition from short- to long-lobed flowers is not abrupt, and there are about four or five intermediate flowers.

Vouchers: *Bolus 11382* (BOL); *Schelpe 7133* (BOL); *Schlieben & Ellis 12387* (PRE); *Sidey 1255 (PRE).*

21. **Holothrix randii** *Rendle* in Journal of Botany, British and Foreign 37: 208 (1899); Summerh.: 11 (1968); J.L.Stewart et al.: 65, t. 1.19 (1982); Kidson & Fletcher: 14 (1984). Type: Rhodesia, Salisbury [Zimbabwe, Harare], in shady woods, *Rand 596* (BM!).

H. reckii Bolus: t. 21 (1913). Type: Transvaal (Gauteng), Koedoespoort, *Reck 1003* (BOL!, PRE!).

Leaves glabrous, withered at anthesis. *Scape* with bracts, 170–420 mm long, minutely pilose with short, fine, sinuous hairs. *Sepals* 2.5–4.5 × 1.5–2.0 mm, glabrous. *Petals* divided into 7–11 fine, filamentous lobes, 6.0–13.5 × 3.0–5.0 mm, white; *lip* divided into 8–15 fine, filamentous lobes (Figure 8F), 10.0–13.5 × 3.0–6.0 mm, white. *Spur* curved to nearly circinnate, 3.5–8.0 mm long.

This species is found at Zebediela (Northern Province) and in Gauteng in the districts of Pretoria and Johannesburg (Figure 13), and occurs also in Tanzania and Zimbabwe. It grows on grassy slopes and rocky ledges. Flowering time: September to December.

H. randii is very similar to *H. schlechteriana* (No. 22) but differs in the fine, hair-like lobes of the lip and petals, in its white (not cream or greenish) petals, and in its distribution. It also tends to have a more strongly curved spur but this does not hold for all specimens.

Vouchers: *Bolus 14082* (BOL); *Codd 6162* (PRE); *Howlett s.n.* (PRE); *McLoughlin 144* (BOL).

22. **Holothrix schlechteriana** *Schltr. ex Kraenzl.* in Orchidacearum genera et species: 588 (1899); Bolus: t. 20 (1913); J.L.Stewart et al.: 65 (1982). Syntypes: rocky area near Clarkson, 5000 ft, *Schlechter 6015* (K!); Queenstown Dist., in mountains near Howieson's Poort, 2000–3000 ft, *Mrs Barber s.n* (not found).

Leaves glabrous, large. *Scape* with bracts, stout, 135–700 mm long, moderately to densely pilose with short, fine, velvety hairs. *Sepals* 2.0–6.0 × 0.5–2.5 mm, glabrous. *Petals* divided at apex into 4–9 filiform lobes, 2.5–10.0 × 1.0–2.5 mm, green to pale greenish cream to yellow-ochre; *lip* divided into 5–11 lobes (Figure 8H), colour as for petals. *Spur* curved, half to nearly equal length of lip, 2.5–5.5 mm long.

This species occurs in a number of scattered localities. It has been recorded from Springbok in the Northern Cape, from Caledon, Montague and Laingsburg, in the Western Cape and it extends into Eastern Cape as far as Steynsburg and King William's Town (Figure 14). It grows in dry areas shaded by rocks or bushes. Flowering time: October to February.

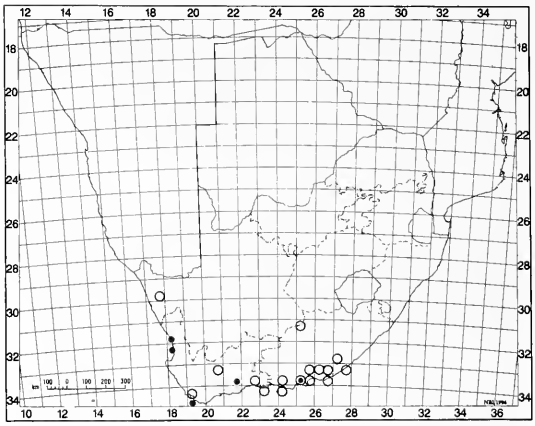

FIGURE 14.—Distribution of *Holothrix schlechteriana*, ○; and *H. grandiflora*, ●.

For characters distinguishing this species from *H. randii* (No. 21), see under that species.

Vouchers: *Acocks 12071, 16511* (PRE); *Ehrens 1962* (PRE); *Hardy & Bayliss 1115* (PRE); *Theron 1399* (PRE).

23. **Holothrix grandiflora** *(Sond.) Rchb.f.* in Otia botanica hamburgensia: 119 (1881); J.L.Stewart et al.: 65, t. 1.21 (1982). Type: Uitenhage, *Wiedemann s.n.* (not found).

Scopularia grandiflora Sond.: 79 (1847).

Leaves glabrous, large, often withered at anthesis. *Scape* with bracts, stout, 190–510 mm long, glabrous or with a few minute hairs at base. *Sepals* 4.5–9.0 × 1.5–4.5 mm, glabrous. *Petals* divided into 5–9 lobes, 10.0–22.0 × 1.5 mm, white with bases green or pale lilac; *lip* 12.5–25.5 × 3.5–6.5 mm (breadth taken at base of flared section), divided into 13–26 lobes (Figure 8I); limb often flared out into a broad distal section; colour as for petals. *Spur* very broadly conical, slightly curved, 1/5–1/4 length of lip, 3.0–4.5 mm long. *Column* with an apiculus.

The records for this species are scattered, and come from the west coast, from Bredasdorp, and from Ladismith in Western Cape and from Port Elizabeth (the type) in Eastern Cape (Figure 14). It grows in hollows and crevices in rocks, under semi-arid conditions. Flowering time: March.

H. grandiflora, the tallest representative of the genus in southern Africa, is similar to *H. schlechteriana.* It can usually be distinguished by the shorter spur to lip ratio, the longer petals, and the nearly glabrous scape; it also generally has a larger number of lip lobes and a flared distal section of the lip. The flowering time is later, being in March, while *H. schlechteriana* flowers mainly from October to December and occasionally in January and February.

Although the type has not been seen, the description by Sonder (1847) is detailed and clearly refers to this species.

Vouchers: *Bruyns 1282* (NBG); *Guthrie s.n.* (BOL); *Hall 3521c* (BOL); *Schelpe 7663* (BOL).

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INDEX TO TAXA

Bothalia 26,2: 141–151 (1996)

FSA contributions 7: Verbenaceae†: *Vitex*

C. L. BREDENKAMP* and D.J. BOTHA**

Editor's note: this contribution duplicates most of the synopsis of the genus *Vitex* published by Bredenkamp & Botha (1993) before the column '*FSA* contributions' was initiated in *Bothalia*. The synopsis lacks species descriptions and can therefore not be accepted as a direct contribution to the *FSA*.

7186000 VITEX

Vitex *L.* in Species plantarum 638 (1753) & Genera plantarum edn 5: 285 (1754); Adans.: 200 (1763); Juss.: 107 (1789); Lour.: 389 (1790); G.Mey.: 218 (1818); Roth: 516 (1821); Endl.: 635 (1836); Schauer: 682 (1847); Seem.: 190 (1865); Benth. & Hook.: 1135 (1876); C.B.Clarke: 583 (1885); Briq.: 170 (1894); Baker: 315 (1900); H.Pearson: 211 (1901); Hutch.: 309 (1926); W.Piep.: 1–91 (1928); Moldenke & A.Moldenke: 32 (1946); Moldenke: 142 (1955a); Moldenke: 186 (1955b); Moldenke: 13 (1957a); Moldenke: 70 (1957b); Moldenke: 129 (1958a); Moldenke: 197 (1958b); Moldenke: 21 (1961a); Melch.: 435 (1964); Merxm.: 9 (1967); Moldenke: 73 (1967a); Moldenke: 222 (1967b); Moldenke: 130 (1973); R.A.Dyer: 520 (1975); Moldenke: 216 (1979a); Moldenke: 328 (1979b); Verdc.: 50 (1992). Type: Mediterranean areas and central Asia. *V. agnus-castus* L. (Farr *et al.* 1979).

Mailelou Rheede ex Adans.: 200 (1763). *Limia* Vand. in Vand. et al.: 42 (1788). *Nephandra* Willd.: 8 (1790). *Allasia* Lour.: 84 (1790). *Tripinna* Lour.: 391 (1790). *Chrysomallum* Thouars: 8 (1806). *Pyrostoma* G.Mey.: 219 (1818). *Wallrothia* Roth: 317 (1821). *Ephialis* Banks, Sol. & A.Cunn.: 461 (1838). *Psilogyne* DC.: 132 (1838). *Casarettoa* Walp.: 91 (1844). *Macrostegia* Nees: 218 (1847).

Trees or shrubs. *Leaves* opposite, palmately compound with 3–5(7) pinnae, margins entire or seldom dentate; petiolule present or pinnae sessile. *Inflorescences* terminal, many-flowered racemes or axillary, determinate compound dichasia. *Flowers* bisexual, slightly zygomorphic or zygomorphic. *Calyx* persistent, enlarging during fruiting stage; tube campanulate, 5-lobed; lobes often reduced. *Corolla* with 5 lobes, bilabiate, mauve; lip with yellow markings at base; tube white, often curved and hairy externally as well as internally, infundibular or campanulate. *Androecium*: stamens 4, didynamous, epipetalous, exserted; filaments basally broadened and hairy; anthers dorsifixed, divergent, extrorse. *Gynoecium*: ovary superior, glabrous, scarcely hairy apically, or hairy in upper half, bicarpellous, 4-locular with a single orthotropous ovule per locule, with axile placentation; style terete, exserted. *Fruit* a 4-loculed drupe, sessile on a firm, crateriform calyx, or a nut enveloped by an infundibular chartaceous calyx. *Seeds* 1–4, oblong to narrowly obovoid.

The genus *Vitex* has a world-wide, tropical to subtropical distribution, and comprises approximately 380 taxa (Verdcourt 1992). Pieper (1928) described 87 taxa from Africa and divided these into the subgenera *Vitex* and *Holmskioldiopsis* W.Piep. Of the six southern African representatives of the subgenus *Vitex*, *Vitex ferruginea* Schumach. & Thonn. subsp. *amboniensis* (Gürke) Verdc., *V. angolensis* Gürke, *V. harveyana* H.Pearson, and *V. mombassae* Vatke have a mainly tropical distribution just extending southwards into southern Africa (*sensu FSA*). Apart from a few records from Zimbabwe and Mozambique, *V. pooara* Corbishley, and *V. patula* E.A.Bruce (subgenus *Vitex*) appear to be restricted to southern Africa. All members of the subgenus *Holmskioldiopsis* are endemic to southern Africa.

1a Calyx crateriform during fruiting stage (Figure 2), firm; fruit fleshy (drupe), globose or ellipsoid: Subgenus *Vitex*:
2a Gynoecium glabrous, or scarcely hairy at apex:
3a Flowers relatively large, 16–18 mm long; young stems ribbed . . . . . 1. *V. harveyana*
3b Flowers relatively small, 5–10 mm long; young stems not ribbed:
4a Adaxial surface of pinnae scarcely hairy, trichomes firm, imparting a rough feel to surface; fruit ellipsoid . . . . . 2. *V. patula*
4b Adaxial surface of pinnae pubescent, velvety; fruit globose . . . . . 3. *V. pooara*
2b Gynoecium velutinous in upper half:
5a Leaves palmate with three pinnae (occasionally five); pinnae sessile (petiolulate pinnae exclusively in Angola); median pinna widely obovate or widely elliptic . . . . . 6. *V. mombassae*
5b Leaves palmate with five pinnae (exceptionally seven); pinnae petiolulate; median pinna narrowly ovate, narrowly obovate or elliptic:
6a Adaxial leaf surface glabrous or scarcely hairy on venation; median pinna 55–142 mm long; petiolule 6–21 mm long . . . . . 4. *V. ferruginea* subsp. *amboniensis*
6b Adaxial leaf surface puberulent; median pinna 26–50 mm long; petiolule absent or up to 5 mm long . . . . . 5. *V. angolensis*
1b Calyx campanulate during fruiting stage (Figure 7), chartaceous; fruit dry (nut), obovoid: Subgenus *Holmskioldiopsis*:
7a Leaves with both surfaces of lamina macroscopically glabrous; median pinna narrowly oblong, narrowly elliptic or lanceolate . . . . . 7. *V. rehmannii*
7b Leaves with both surfaces of lamina hairy; median pinna oblong, elliptic, narrowly ovate or narrowly obovate:
8a Adaxial lamina surface densely velvety with white hairs; leaves greyish green . . . . . 8. *V. zeyheri*
8b Adaxial lamina surface glabrous or pubescent with white hairs; fresh leaves dark green . . . . . 9. *V. obovata*

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MS. received: 1996-05-20.
† Labiatae could be expanded to include the Viticoideae (Cantino 1992: 35).

SUBGENUS *VITEX*

Subgenus **Vitex**

Euvitex W.Piep.: 29 (1928). According to Art 21(3) of the International Code (Greuter *et al.* 1994) *Euvitex* must be rejected.

Flowers with total length 6–18 mm, strong tendency towards zygomorphy. *Calyx* 5-lobed; lobes often reduced, 0.5–1.5 mm long. *Corolla* tube 3.8–10.0 mm long; lobes 5, dorsal lobes almost completely fused. *Ovary* globose or broadly flask-shaped, glabrous or hairy in upper half. *Fruit* a drupe, ellipsoid to globose, 10(–21) × 7(–21)mm, sessile on a persistent, firm, crateriform calyx.

Section **Axillares** *Briq.* emend. *W.Piep.* in Botanische Jahrbücher 62,3, Beiblatt 142: 30 (1928). Type: *V. ferruginea* Schumach. & Thonn. Ghana near Aquapim, *Thonning* 265 (C, syn., P-JU, isosyn.)

Axillares Briq.: 172 (1894).

1. **Vitex harveyana** *H.Pearson* in Flora capensis 5: 212 (1901); W.Piep.: 56 (1928); Moldenke: 40 (1961a); Compton: 66 (1966); Moldenke: 257 (1971a); Palmer & Pitman: 1951 (1973); Coates Palgrave: 808 (1977). Type: eastern region, banks of the higher Tugela River, *Gerrard & McKen 1250* (PRE, lecto.!, fide Bredenkamp & Botha (1993); K, photo.!).

V. geminata H.Pearson: 213 (1901); W.Piep.: 56 (1928); Moldenke: 257 (1971b). *V. harveyana* forma *geminata* (H.Pearson) Moldenke: 329 (1979b). Type: eastern region, Zululand, at the Umlasi River, *Gerrard & McKen 2027* (TCD, holo. photo.!; K!).

V. schlechteri Gürke: 299 (1904); W.Piep.: 56 (1928); Moldenke: 389 (1959); Moldenke: 727 (1971a). Type: Komatipoort, *Schlechter 11731* (Z, holo.!; E!, G!, GRA!, K, photo.!; P!, S!, W!).

Shrubs 2–3(–4) m high, many-stemmed with lax shoots; adventitious roots borne at nodes; young stems angular, striated, often ribbed; cork grey-brown, finely striated. *Leaves* palmately compound with 3–5 pinnae; petiole (10–)20–22(–39) mm long, adaxially grooved, abaxially convex, glabrous; petiolule (0–)6–7(–10) mm long, glabrous; median pinna (30–)53–55(–79) × (16–)23–24(–29) mm, elliptic to narrowly obovate; margin entire or toothed in upper half; dark green, surface shiny, waxy, adaxial surface glabrous, abaxial surface sparsely pubescent, glandular trichomes present. *Inflorescence* a compound dichasium, total length (30–)52–55 (–85) mm; length of bracts at first branch of inflorescence (1–)3–4(–15) mm. *Pedicel* resupinating. *Flowers* zygomorphic, total length in lateral view 17 mm. *Calyx*: tube (4.0–)4.2–4.5(–5.0) mm; lobes reduced, 0.5 mm long. *Corolla* violet; tube 10–12 mm long; lobes in front view 22 × 17(–18) mm, dorsal lobes folded backwards parallel to tube. *Androecium:* longest pair of stamens 10–11 mm, shortest pair 9 mm long. *Ovary*: style 14 mm long. *Fruit* a fleshy drupe, sessile on a firm crateriform calyx, ellipsoid (5–)9–10(–12) × (4–)7–8(–9) mm, black when ripe.

Distribution and habitat: Mpumalanga, especially near Komatipoort, Swaziland, NE KwaZulu-Natal and Eastern Cape; also recorded from Angola and Mozambique (Figure 1). Most frequently grows between rocks in sandy soil or on river and stream banks. *Flowering time*: October to December. *Common names*: Umbendula (Zulu); three-finger-leaf, three-finger vitex, whorled finger-leaf (English); drievingerblaar, krantzvingerblaar, kransvingerblaar (Afrikaans). *Utilisation*: fruit edible from February to May.

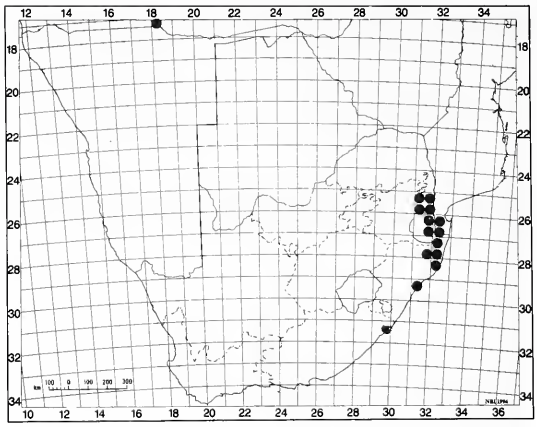

FIGURE 1.—Distribution of *Vitex harveyana* in southern Africa.

Vouchers: *Bredenkamp 255* (PUC); *Codd 5242* (K, PRE, NH); *Gerstner 4212* (NH); *Rogers TM13278* (PRE, NH).

2. **Vitex patula** *E.A.Bruce* in Bruce et al. in Bothalia 6: 237 (1951); Moldenke: 44 (1957a); Moldenke: 40 (1961a); Moldenke: 317 (1967d); Moldenke: 258 (1971b); Palmer & Pitman: 1962 (1973); J.H.Ross: 300 (1972); Coates Palgrave: 809 (1977). Type: Transvaal [Northern Province], Zoutpansberg Dist., Kruger National Park, Dzundweni Hill, 11.5 miles SE of Punda Maria, *Codd 5319* (PRE, holo.!).

Multistemmed shrub (1.0–)2.4–4.0(–5.0) m high; cork grey-brown and striated; young stem hairy. *Leaves* palmately compound with 3–5 pinnae, frequently 3 pinnae present, arranged at right angles; petiole (26–)45–49 (–112) mm long, sparsely tawny-pubescent; petiolule (2–)4–5(–9) mm long, sparsely tawny-pubescent; median pinna (39–)61–66(–144) × (17–)31–32(–60) mm, elliptic to narrowly obovate, margin entire or toothed in upper half, dark green, adaxial surface scabrous due to presence of macroscopical sturdy trichomes, abaxial surface sparsely hairy; chartaceous. *Inflorescence* a compound dichasium, total length (29–)59–62(–105) mm; length of bracts at first branch of inflorescence (4–)9–10(–22) mm. *Flowers* zygomorphic, total length (5.0–)6.0–7.0(–9.4) mm. *Calyx* enlarges during fruiting stage, (3.0–)3.2–3.4 (–3.8) mm; lobes (0.5–)0.7–0.9 (–1.28) mm long. *Corolla*: tube white, lobes mauve; tube (3.8–)4.0–5.0 (–6.0) mm long; lobes in front view 8.0–8.5 × (6.0–) 6.5–7.0(–8.0) mm, held at right angles to tube. *Androecium*: longest pair of stamens 4.0–4.8 mm, shortest pair (3.6–)3.7–3.8(–4.0) mm, not exserted. *Ovary* glabrous; style (4.9–)5.0–5.1 (–5.4) mm long. *Fruit* a fleshy drupe, sessile on a firm crateriform calyx, ellipsoid, (9.0–)11.0–12.0(–13.0) × (7.0–) 7.5–8.0(–9.0) mm, black when ripe. Figure 2.

FIGURE 2.—*Vitex patula*: A, habit, reduced, height variable, ± × 0.01; B, flowering branch, × 0.5; C, variation in leaf shape, × 0.25; D, fruiting inflorescence, × 2; E, side view of flower, × 6; F, flower face showing corolla lobes, × 5. Drawn from *Bredenkamp 272* and *Botha 3969* (PRE). Artist: Gillian Condy.

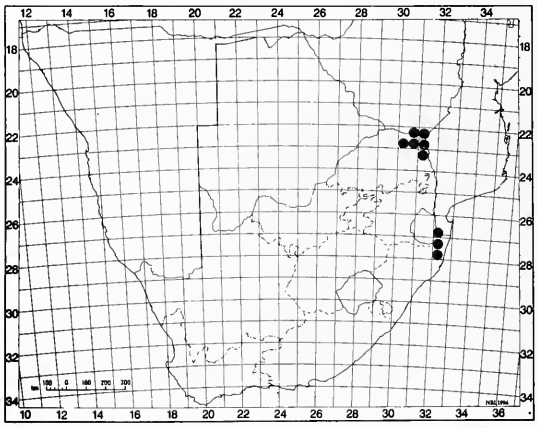

FIGURE 3.—Distribution of *Vitex patula* in southern Africa.

Ross (1972) and Von Breitenbach & Von Breitenbach (1995) treat *V. patula* as a synonym of *V. amboniensis* Gürke [see *V. ferruginea* Schumach. & Thonn. subsp. *amboniensis* (Gürke) Verdc. var. *amboniensis*]. Morphological and anatomical studies have shown that they are separate taxa (Bredenkamp 1988).

Distribution: NE parts of Northern Province, Venda, Kruger National Park and N KwaZulu-Natal; also in Mozambique (Figure 3). *Flowering time*: end of November to December.

Vouchers: *Bredenkamp 247, 248 & 267* (PUC); *Gomes & Sousa 3885* (PRE); *Pooley 780,* (NH); *Van der Schijff 3343* (PRE).

3. **Vitex pooara** *Corbishley* in Kew Bulletin 10: 333 (1920); I.Verd.: 45 (1938); Moldenke: 89 (1957b); Moldenke: 388 (1959); Moldenke: 76 (1961b); Moldenke: 258 (1971b); Palmer & Pitman: 1953 (1973); Coates Palgrave: 810 (1977). Type: Transvaal [Northern Province], Modder Nek, Nylstroom, *I.B. Pole Evans 19671* (PRE, holo.!; K, photo.!).

Small to medium-sized trees, to 5 m high; branches spreading; cork grey-brown, incised, peels in strips; young stems tawny. *Leaves* palmately compound with 3–5 pinnae; petiole (27–)45–46(–63) mm long, sparsely tawny-pubescent; petiolule usually absent. Pinnae tawny at base; median pinna (39–)58–60(–75) × (16–)27–28(–37) mm, narrowly obovate, margin entire, yellow green to khaki, both ad- and abaxial surfaces are pubescent, glandular trichomes present on both surfaces; coriaceous. *Inflorescence* a compound dichasium, total length (34–)54–56 (–84) mm; length of bracts at first branch of inflorescence (5–)7–8(–15) mm. *Flowers* zygomorphic, total length 6 mm. *Calyx*: tube 2 mm; lobes 0.5 mm. *Corolla*: tube strongly curved, 5 mm long, white; lobes in front view 8.5 × 8.0 mm, held at right angles to tube. *Androecium*: longest pair of stamens 4 mm, shortest pair 3.5 mm, not exserted. *Ovary* glabrous, sparsely pubescent at apex; style 4.5 mm long. *Fruit* a fleshy drupe, sessile on a firm crateriform calyx, spheroid or ellipsoid, (9–)14–15(–18) × (9–)12–13(–18) mm, black when ripe.

Bredenkamp (1988) has shown that *V. pooara* and *V. mombassae* Vatke are morphologically and taxonomically clearly defined and cannot be regarded as synonymous (Coates Palgrave 1977; Von Breitenbach & Von Breitenbach 1995). A study of the type material has also shown that *V. pooara* is related to the tropical *V. isotjensis* Gibbs (Corbishley 1920), but that these taxa are not conspecific.

Distribution: rare in North-West and Northern Provinces and Gauteng, found especially in the vicinities of Nylstroom, Thabazimbi and Rustenburg (Figure 4); also recorded for S Zimbabwe. *Flowering time*: end of November to December. *Common names*: pooar (Corbishley 1920); mphoer or mphuru, referring to the characteristic 'house-bug' odour (*Theron 2049*, PRE); hardekool, poerabessie, poera(s)boom, stinkbessie, weeluisbessie (Afrikaans); poora-berry, resin-leaf and wild cherry. *Utilisation*: Moldenke (1961b) mentions that the wood is not fit for utilisation. The fruit is eaten by the local people (Verdoorn 1938).

Vouchers: *Bredenkamp 238* (PUC); *Carlson* in *PRE1481* (PRE); *Galpin 11652* (PRE); *Westfall 1556* (PRE).

4. **Vitex ferruginea** *Schumach. & Thonn.*, Beskrivelse af Guineiske planter: 62 (1827); Baker: 324, 521 (1900); W.Piep.: 70 (1928); H.Huber in Huber et al.: 447 (1963); Hepper: 130 (1976). Type: Ghana near Aquapim, *Thonning 265* (C, syn., P-JU, isosyn.).

subsp. **amboniensis** *(Gürke) Verdc.* in Flora of tropical East Africa: 66 (1992). Type: East Africa, Amboni, *Holst 2578* (B, holo.†; HBG, iso.!; K, iso., photo.!).

Shrubs 2.5–3.0(–9.0) m high; multistemmed with long lax shoots; cork grey-brown, incised, peels in strips; young stems and growing points with tawny indumentum. *Leaves* palmately compound with 3–7 pinnae; petiole (36–)63–65(–125) mm long, tawny-pubescent; petiolule slender, (6–)11–12(–21) mm long, tawny-pubescent; median pinna (54–)80–87(–142) × (18–)30–31(–58) mm, elliptic to narrowly ovate, acute or obtuse, apex acute to acuminate, margin entire or toothed in upper half, yellow

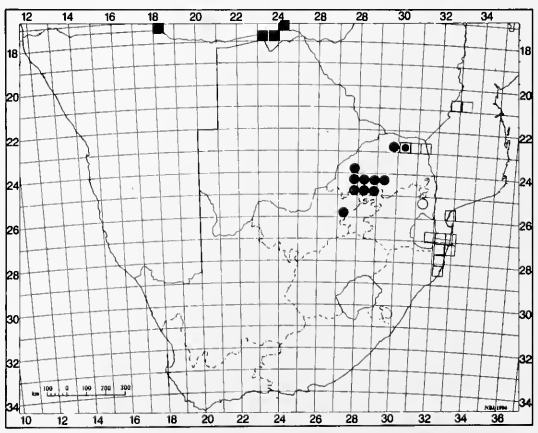

FIGURE 4.—Distribution of *Vitex pooara*, ●; *V. ferruginea* subsp. *amboniensis* var. *amboniensis*, ❑; *V. ferruginea* subsp. *amboniensis* var. *amaniensis*, ○; *V. angolensis*, ■, in southern Africa.

to dark green, adaxial surface glabrous to sparsely pubescent, abaxial surface yellowish pubescent, glandular trichomes present; softly chartaceous. *Inflorescence* a compound dichasium, total length (16–)31–32(–50) mm, tawny-pubescent; length of bracts at first branch of inflorescence (5–)9–10(–15) mm. *Flowers* zygomorphic, total length 14–15 mm. *Calyx*: tube (3.0–)3.5–4.0(–5.0) mm long; lobes 0.5–1.5 mm long. *Corolla*: tube white, lobes and lip mauve, older flowers cream-coloured; tube strongly curved, (8.0–)8.5–9.5(–10.0) mm long; lobes in front view (15–)16–17(–19) × 11–12 mm, dorsal lobe folded backwards, parallel to tube. *Androecium*: longest pair of stamens (8.0–)9.0–9.7(–10.0) mm, shortest pair (6.0–)7.0–7.2(–8.0) mm, not exserted. *Ovary* velutinous in upper half; style 6.4–10.0 mm long. *Fruit* a fleshy drupe, sessile on a firm crateriform calyx, spheroid or ellipsoid (18–)20–21(–22) × (15–)20–21(–23) mm, purplish black when ripe.

Two varieties can be distinguished:

1a Adaxial surface of pinnae glabrous or scarcely hairy; apex acute, acuminate or characteristically cuspidate . . . . . 4a. var. *amboniensis*

1b Adaxial surface of pinnae puberulent; apex rounded to acute and not acuminate . . . . . 4b. var. *amaniensis*

4a. var. **amboniensis**

V. amboniensis Gürke: 340 (1895); Baker: 329 (1900); Sim: 94 (1909); Moldenke: 204 (1955b); Moldenke: 380 (1959); Moldenke: 28 (1961a); Dale & Greenway: 539 (1961); Moldenke: 227 (1967b); Moldenke: 496 (1968a); Van der Schijff: 81 (1969); Moldenke: 257 (1971b); Palmer & Pitman: 1955 (1973); Coates Palgrave: 807 (1977); Moldenke: 361 (1979b).

V. tangensis Gürke: 339 (1895): Baker: 321 (1900); W.Piep.: 68 (1928). Type: Tanzania, Tanga, *Volkens* 92 (B, holo.†).

V. amboniensis Gürke var. *schlechteri* W.Piep.: 69 (1928); Moldenke: 120 (1949); Moldenke: 206 (1955b); Moldenke: 89 (1967a). Type: East Africa, Lourenço Marques [Mozambique, Maputo], *Schlechter 11715* (BOL, iso.; GRA!).

V. polyantha Baker: 321 (1900). Type: Kenya, Mombassa, *Wakefield* (K, holo.).

V. laevigata Baker: 330 (1900); W.Piep.: 69 (1928). Type: German East Africa: Usaramo; Dar-es-Salaam [Tanzania] *Kirk s.n.* (K, holo. photo.!).

V. swynnertonii S.Moore: 168 (1911); W.Piep.: 70 (1928). Type: Mozambique, Gazaland, *Swynnerton 1054* (BM, holo.!)

Distinguished from var. *amaniensis* by the characters given in the key above.

Distribution and habitat: Venda in Northern Province, NE Kruger National Park (especially at Nwambiya), Swaziland and NE KwaZulu-Natal; also Mozambique (Figure 4). This plant occurs sympatrically with *V. patula* in deep sand in sand forests. *Flowering time*:*V. ferruginea* subsp. *amboniensis* var. *amboniensis* and *V. patula* are sympatric species, but the former flowers in early and the latter in late December. Fruits ripen in May. *Common names*: mufudu (Gir.) (Gürke 1895; Dale & Greenway 1961); miahali (Watt & Breyer-Brandwijk 1962); mupfumbu-pfumbu (V) (Palmer & Pitman 1972); large-fruited vitex, Amboni vitex, plum finger-leaf (English); pruimvingerblaar, (Afrikaans). *Utilisation*: Watt & Breyer-Brandwijk (1962) mentions that the plant is used as a remedy against snakebite by the Swahili. The fruit is not edible (Palmer & Pitman 1972).

Vouchers: *Balsinhas 242* (PRE); *Bredenkamp 268* (PRE, PUC); *Carvalho 671* (PRE); *Codd 5434* (PRE, SRGH); *Van Wyk 4015* (PRE, PRU); *Ward 2731* (PRE, NH).

4b. var. **amaniensis** (*W.Piep.*) *Verdc.* in Flora of tropical East Africa: 67 (1992); W.Piep.: 69 (1928); Moldenke: 206 (1955b); Moldenke: 29 (1961a). Type: East Africa, Amani, *Institut Amani 221a* (B, holo.†).

Distinguished from var. *amboniensis* by the characters given in the key above.

Distribution and habitat: only known from the Kruger National Park (Mpumalanga) at Numbi, and Shabeni Hill near Pretoriuskop, where the shrub was found at the foot of the massive rocky summit of the hill (Figure 4). *Flowering time*: flowers were scarce but could still be found in the beginning of February.

Vouchers: *Bredenkamp 225* (PRE, PRU); *Van der Schijff 152 & 740* (PRE, KNP).

5. **Vitex angolensis** *Gürke* in Botanische Jahrbücher 18: 167 (1893); Baker: 325 (1900); Hiern: 835 (1900); W.Piep.: 70 (1928); Gossw.: 382 (1953); Moldenke: 207 (1955b); Moldenke: 98 (1967a); Moldenke: 227 (1967b). Type: Angola, *Welwitsch 5758* (BM, holo.!; K!, LISC!).

Shrubs 1.5(–3.0) m high, multistemmed and well branched; cork grey-brown, incised, peels in strips; young stems and growing points with tawny indumentum. *Leaves* palmately compound with 3–7 pinnae; petiole (13–)34–37(–54) mm long, tawny-pubescent; petiolule slender, (0–)2–3(–5) mm long, tawny-pubescent; median pinna (26–)40–41(–55) × (12–)18–20(–24) mm, elliptic to narrowly obovate, apex acute or obtuse, margin entire or irregularly toothed in the upper half, yellow to dark green, ad- and abaxial surfaces yellowish pubescent, glandular trichomes present; softly chartaceous. *Inflorescence* a compound dichasium, total length (29–)31–33(–41) mm, tawny-pubescent; length of bracts at first branch of inflorescence (5.0–)5.8–6.0(–7.0) mm. *Flowers* zygomorphic, total lateral length 11 mm. *Calyx*: tube 4.5–5.0 mm long; lobes 1.0–1.5 mm long. *Corolla*: tube strongly curved, 9–10 mm long; lobes in front view 12.0(–13.5) × 9.0 mm, not folded backwards against tube. *Androecium*: longest pair of stamens 8 mm, shortest pair 6 mm, not exserted. *Ovary* velutinous in upper half; style 10 mm long. *Fruit* a fleshy drupe, sessile on a firm crateriform calyx, spheroid or ellipsoid, (13–)17–18(–25) × (9–)14–15(–23) mm, purplish black when ripe.

Distribution and habitat: Kuring-Kuru in Namibia, and E Caprivi (Figure 4); also from Angola, especially at Huila. This plant and *V. mombassae* grow sympatrically in deep sand. Flowering time seems to be the isolating mechanism between these taxa, as *V. angolensis* flowers earlier than *V. mombassae*. *Flowering time*: December to mid-January. Fruits ripen between May and June. *Common names*: Gossweiler (1953) mentions that the name muvomba (Ganguela) is used in the Vila da Ponte [Kuvango]; according to information obtained from herbarium specimens, the names mufilo and mumpula are also used.

Vouchers: *Bredenkamp 296* (PUC); *Geldenhuys 321* (PRE); *Jankowitz 1334* (PRE, WIND).

6. **Vitex mombassae*** *Vatke* in Linnaea 43: 533 (1882); Gürke: 339 (1895); Baker: 326 (1900), pro parte; Th.Dur. & H.Dur.: 437 (1909); W.Piep.: 66 (1928); Moldenke: 120 (1949); Gossw.: 381 (1953); Moldenke: 383 (1959); Dale & Greenway: 597 (1961); Moldenke: 47 (1961a); Moldenke: 12 (1968b); Moldenke: 717 (1971a); Verdc.: 155 (1989); Verdc.: 63–64 (1992). Type: Kenya, prope Mombassa in ora Zanzibarensi [near Mombassa, on the Zanzibar Coast], *Hildebrandt 1972* (B, holo.†; BM, iso.!, K, iso.!).

V. flavescens Rolfe: 87 (1893); Baker: 321 (1900); Moldenke: 383 (1959); Merxm.: 122 (1967); Moldenke: 717 (1971a). Syntypes: Malange, *S. Marques 8;* Angola, *Welwitsch 5731* (BM!; K!, P!).

V. mechowii Gürke: 167 (1893); Hiern: 834 (1900); Moldenke: 386 (1959); Moldenke: 722 (1971a). Syntypes: Angola, *Welwitsch 5731* (BM!, K!, P!); Malange, *Mechow 247* (B, †).

V. goetzei Gürke: 464 (1900); Baker: 521 (1900); Moldenke: 383 (1959); Moldenke: 718 (1971a). Type: Sansibar-Küstengebiet: in der Steppe südlich des Rufidji [Zanzibar coastal region in the steppe south of the Rufidji], *M. Goetze 85* (B, holo.†; K, iso.!).

V. shirensis Baker: 326 (1900); Moldenke: 389 (1959); Moldenke: 727 (1971b). Syntype: *Buchanan 231*, fide Verdcourt (1992).

V. mufutu De Wild.: 142 (1914); Moldenke: 386 (1959); Moldenke: 723 (1971a). Type: Ober-Katanga, Etoile du Congo [Zaïre]. No collector or number mentioned.

V. mombassae Vatke var. *acuminata* W.Piep.: 68 (1928); Moldenke: 267 (1967c). Type: Britisch-Ost-Afrika [Kenya] *Battiscombe 2* (K, holo.!).

V. mombassae Vatke var. *parviflora* (Gibbs) W.Piep.: 68 (1928); Moldenke: 717 (1971a). *V. flavescens* Rolfe var. *parviflora* Gibbs: 463 (1906); Gibbs: 459 (1916). Type: Hab. Victoria Falls, veld, *Gibbs 135* (BOL, holo.!; BM!, SAM!).

Shrubs 2–3 m high; multistemmed and well branched; cork grey-brown, incised, peels in strips; young stems and growing points with tawny indumentum. *Leaves* palmately compound with 3–5 pinnae; petiole (23–)48–50 (–88) mm long, tawny-pubescent; petiolule usually absent, 0–1.5(–11) mm long, tawny pubescent; median pinna (37–)60–65(–108) × (19–)35–40(–65) mm, broadly obovate, base acute to obtuse, apex obtuse, rounded or mucronulate, margin entire, yellow green, ad- and abaxial surfaces yellowish pubescent, glandular trichomes present, chartaceous to coriaceous. *Inflorescence* a compound dichasium, total length (31–)57–62(–125) mm, tawny-pubescent; length of bracts at first branch of inflorescence (3–)9–10(–22) mm. *Flowers* zygomorphic, total length 11 mm. *Calyx:* tube 4 mm long; lobes 1.5 mm long. *Corolla:* tube strongly curved, 8 mm long; lobes in front view 16 × 11 mm, folded backwards against tube. *Androecium*: longest pair of stamens 9 mm, shortest pair 8 mm, exserted. *Ovary* velutinous in upper half; style 10 mm long. *Fruit* a fleshy drupe, sessile on a firm crateriform calyx, spheroid or ellipsoid (8–)18–20(–33) × (10–)15–16(–31) mm, purplish black when ripe.

Pieper (1928) mentioned the occurrence of *V. mombassae* var. *erythrocarpa* (Gürke) W.Piep. in Livingstone, Zambia. This variety does not seem to extend into southern Africa and no material of it was seen.

Distribution and habitat: N Namibia; also in Angola, Zimbabwe and Mozambique (Figure 5). *V. mombassae* and *V. angolensis* are sympatric species growing in deep sand. *Flowering time*: December to early January. Fruits ripen in May. *Common names*: lufuka (Durand & Durand 1909); mfudumaji (Swa.); mfududu (Gir.); mfudukoma (Dig.); mkufu (San.); mkalijote (Bon.) (Dale & Greenway 1961); muxilo-xilo (Kimbundu) (Gossweiler 1953); mwevumdu mazi (*Taylor 1886*, PRE); mushembere and mbukushu (*De Winter & Marais 4769*, PRE). *Utilisation*: fruit is edible.

Vouchers: *Bredenkamp 299* (PUC); *De Winter & Marais 4796* (PRE, WIND); *Hornby 2342, 2752* (PRE) N Mozambique; *Mendonça 869* (LISC) Angola.

SUBGENUS *HOLMSKIOLDIOPSIS*

Subgenus **Holmskioldiopsis** *W.Piep.* in Botanische Jahrbücher 62,3, Beiblatt 142: 30 (1928). Type: *V. obovata* E. Mey., in valle inter Komga et Kei [in a valley of the Kei Rivier, near Komga] *Drège s.n.* (K!, BM!, G!, MO!, OXF!, P!, S!).

Flowers with total length 6–10 mm, regular. *Calyx* 5-lobed, lobes 1.5–3.5 mm long; tube 3–4 mm long; external surface glandular pubescent, internal surface glandular. *Corolla*: tube straight 6–9 mm long; lobes 5, front view of lobes 10.0–11.0 × 6.0–6.5 mm, situated at right angles to tube; tube white, lobes mauve. *Androecium* didynamous, longest pair of stamens 6 mm and shortest pair 5 mm, exserted. *Ovary* globose or obovoid, hairy and white glandular in upper half; style 6–9 mm long. *Fruit* dry, obovoid, 3 × 4 mm, sessile in base of a persistent, chartaceous, campanulate calyx.

7. **Vitex rehmannii** *Gürke* in Bulletin de l'Herbier Boissier 4: 818 (1896); H.Pearson: 214 (1901); Galpin: 23 (1923); W.Piep.: 74 (1928); Hutch.: 335 (1946); Moldenke: 122 (1949); Moldenke: 112 (1957b); Moldenke:

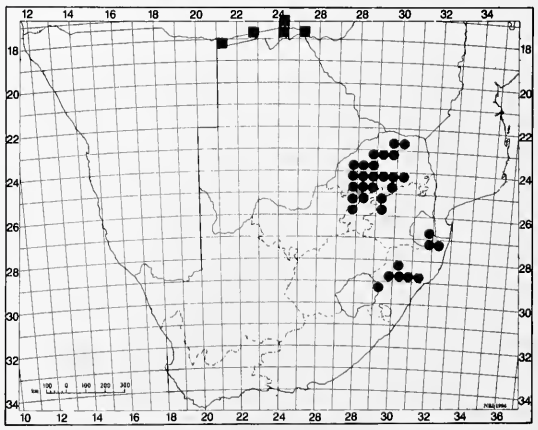

FIGURE 5.—Distribution of *Vitex mombassae* (subgenus *Vitex*), ■; *V. rehmannii* (subgenus *Holmskioldiopsis*), ●, in southern Africa.

*Until recently the correct name for this taxon was *Vitex payos* (Lour.) Merr. (Verdcourt 1989, 1992). However, since this name has been conserved with a new type (Nicolson & Brummitt 1994), the correct name is *V. mombassae* Vatke.

388 (1959); Moldenke: 78 (1961b); Moldenke: 34 (1968b); Moldenke: 258 (1971b); Palmer & Pitman: 1957 (1973); Coates Palgrave: 811 (1977). Type: Transvaal [Northern Province], Makapansberg Mtns, Strydpoort, *Rehmann 5422* (Z, holo.!; BM!, K!).

Trees (2–)3–4(–9) m high; single-stemmed and well branched; cork dark grey-brown, fissured, rough, tessellate; young stems and growing points glabrous or sparsely white-pubescent. *Leaves* palmately compound with 3–5 pinnae; petiole (9–)30–35(–55) mm long, glabrous or sparsely white-pubescent; petiolule slender, (0–)5–6(–18) mm long, sparsely hairy; median pinna (34–)60–65(–135) × (9–)17–18(–31) mm, narrowly oblong, narrowly elliptic or lanceolate, apex as well as base acute, margin entire or toothed in upper half; yellow green to khaki; adaxial surface glabrous to sparsely pubescent, glandular, abaxial surface sparsely pubescent and glandular; chartaceous. *Inflorescence* a compound dichasium, total length (35–)45–60 (–95) mm, sparsely white-pubescent; length of bracts at first branch of inflorescence (1–)9–10(–22) mm. Description of flowers and fruit as for subgenus.

Distribution and habitat: North-West, Gauteng, Northern Province (particularly common in the Waterberg area) and Mpumalanga, Swaziland and KwaZulu-Natal (Figure 5). These plants grow mainly in frost free areas, and a clear discontinuity is visible in the distribution of this taxon from the northern provinces to KwaZulu-Natal. *V. rehmannii* frequently grows on quartzite ridges, on sandstone and also in deep sand. *Flowering time*: December to February. Fruits ripen in April. *Common names*: mokoele (Sesuto) (Galpin 1923); manohani (Shangaan); umduli, umluthu (Z); mokwele (NS) (Palmer & Pitman 1972); pipe-stem tree (English); pypsteelboom, vaalbos (Afrikaans). *Utilisation*: Galpin (1923) describes the wood as yellow-grey and of medium hardness as well as weight. The grain is straight, short and of reasonable strength; the wood is easy to work with and gives a beautiful finish; it is not infested by termites after utilisation but it is seldom used due to the availability of stronger wood types. The local people use it to produce stools. The young stems are hollow and used to make pipe stems.

Vouchers: *Bredenkamp 200, 285* (PRE, PUC); *Galpin M.282* (PRE); *Meeuse 9491* (topotype) (MO, PRE, SRGH); *Wood 6794* (NH, PRE).

8. **Vitex zeyheri** *Sond. ex Schauer* in A.P. De Candolle, Prodromus systematis naturalis regni vegetabilis 11: 639 (1847); Kuntze: 258 (1898); H.Pearson: 216 (1901); W.Piep.: 74 (1928); Moldenke: 122 (1949); Moldenke: 230 (1958b); Moldenke: 154 (1959); Palmer & Pitman: 1959 (1973); Coates Palgrave: 812 (1977). Type: in ripis flum. Crocodillorum in inter. Afric. austr. [North-West: on the banks of the Crocodile River], *Burke & Zeyher 73* (K, holo., photo.!; BM!, PRE!, SAM!).

V. zeyheri Sond. ex Schauer var. *brevipes* H.Pearson: 216 (1901); W.Piep.: 74 (1928); Moldenke: 122 (1949); Moldenke: 231 (1958b); Moldenke: 154 (1959). Type: Transvaal [North-West], Magaliesberg near Crocodile River, *Zeyher 1369* (BOL, holo.!; BM!, G!, K!, OXF!, P!, SAM!, S!, W!).

V. rehmannii Gürke forma *subtomentosa* Moldenke: 20 (1954); Moldenke: 113 (1957b); Moldenke: 154 (1959); Moldenke: 79 (1961b); Moldenke: 34 (1968b); Moldenke 258 (1971b). Type: Transvaal [Gauteng]: Wonderboom Nature Reserve, Pretoria, *Repton 2781* (PRE, holo.!).

Trees (2.5–)3.0–4.0(–6.0) m high; single-stemmed, diameter (120–)200–225(–250) mm; cork dark grey-brown, fissured, rough, tessellate; young stems and growing points glabrous or sparsely white-pubescent. *Leaves* palmately compound with 3–5 pinnae; petiole (10–)25–30 (–41) mm long, white-tomentose; petiolule (0–)2–3(–5) mm long, white-tomentose; median pinna (36–)55–60 (–78) × (10–)28–30(–41) mm, oblong, elliptic, narrowly ovate or narrowly obovate, grey-green, base acute, apex acute, obtuse or rounded, margin entire or toothed in upper half, ad- and abaxial surfaces white-tomentose and glandular; chartaceous. *Inflorescence* a compound dichasium, total length (34–)55–60(–81) mm, white-tomentose; length of bracts at first branch of inflorescence (4–)11–12(–25) mm. Description of flowers and fruit as for subgenus.

Distribution and habitat: endemic to Gauteng, North-West and Botswana (Figure 6). These plants grow mainly in stony soil on south and east facing slopes of the Magaliesberg Mountains and associated ridges. In the Zeerust District it was found on shale, but it occurs on dolomite in the vicinity of Pretoria and Marico. *Flowering time*: December and January, occasionally up to March. Fruits ripen in April and May. *Common names*: mokwele (Tsw) (Palmer & Pitman 1972); silver pipe-stem tree (English); vaalpypsteelboom en vaalbos (Afrikaans).

Vouchers: *Bredenkamp 91* (PUC); *Hutchinson 2927* (GRA, PRE); *Phillips 558* (PRE); *Pole Evans H18060* (PRE).

9. **Vitex obovata** *E.Mey.*, Commentariorum de plantis Africae australioris: 273 (1835); Walp.: 87 (1844); Schauer: 693 (1847); H.Pearson: 214 (1901); Sim: 287 (1907); W.Piep.: 74 (1928); Moldenke: 23 (1957a); Moldenke: 154 (1959); Moldenke: 312 (1967d); Moldenke: 258 (1971b); Palmer & Pitman: 1961 (1973); Coates Palgrave: 810 (1977). Type: in valle inter Komga et Key [in a valley of the Kei River near Komga], *Drège s.n.* (K, holo.!; BM!, G!, MO!, OXF!, P!, S!).

V. reflexa H.Pearson: 215 (1901); W.Piep.: 74 (1928); Moldenke: 225 (1958b); Moldenke: 388 (1959); Moldenke: 727 (1971a); Coates Palgrave: 812 (1977). *V. wilmsii* Gürke var. *reflexa* (H.Pearson) W.Piep.: 74 (1928); Moldenke: 225 (1958b); Moldenke: 122 (1949); Moldenke: 154 & 388 (1959); Moldenke: 258 & 727 (1971a); Palmer & Pitman: 1961 (1973); Coates Palgrave: 812 (1977). Type: Transvaal [Mpumalanga], in

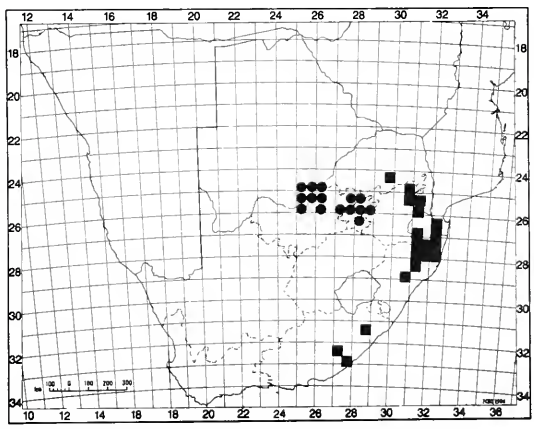

FIGURE 6.—Distribution of *Vitex zeyheri*, ●; *V. obovata* subsp. *obovata*, ■, in southern Africa.

FIGURE 7.—*Vitex obovata* subsp. *wilmsii*: A, habit, reduced, height variable, ± × 0.01; B, flowering branch, × 0.5; C, variation in leaf shape, × 0.33; D, fruiting inflorescence, × 2; E, side view of flower, × 4; F, flower face showing corolla lobes, × 3. Drawn from *Bredenkamp 291*, *293* and *295* (PRE). Artist: Gillian Condy.

dongas around Barberton, *Galpin 602* (BOL, holo.!; GRA!, PRE!, SAM!, SRGH!, Z!).

Trees (2.5–)3.0–4.0(–9.0) m high; single stemmed, diameter (120–)220–250(–300) mm; cork dark grey-brown, fissured, rough, tessellate; young stems and growing points glabrous or sparsely white-pubescent. *Leaves* palmately compound with 3–5 pinnae; petiole (14–)23–38 (–49) mm long, glabrous of sparsely white-pubescent; petiolule (0–)4–7(–12) mm long, sparsely pubescent; median pinna (31.5–)51–74(–99) × (17–)21–29(–48) mm, elliptic, narrowly ovate or narrowly obovate, yellow-green to khaki or dark green, base acute, apex acute, shortly acuminate or rounded, margin entire or toothed in the upper half, adaxial surface glabrous, occasionally sparsely pubescent and glandular, abaxial surface pubescent and glandular, chartaceous. *Inflorescence* a compound dichasium, total length (33–)56–83(–120) mm, white-pubescent; length of bracts at first branch of inflorescence (4–)9–13(–19) mm. Description of flowers and fruit as for subgenus.

Two subspecies are distinguished:

1a Adaxial leaf surface appearing glabrous due to the lack of linear trichomes; median pinna (17–)21–29(–48) mm broad . . . . . 9a. subsp. *obovata*

1b Adaxial leaf surface pubescent due to the presence of linear trichomes; median pinna (22–)37–38(–70) mm broad . . . . . 9b. subsp. *wilmsii*

9a. subsp. **obovata**

Distinguished from subsp. *wilmsii* by the characters given in the key above.

Distribution and habitat: Northern Province, Mpumalanga, particularly in the vicinity of Barberton, NE KwaZulu-Natal, Swaziland and Eastern Cape as far south as Komga and the Kei River, the southernmost record of the genus in Africa (Figure 6). The habitat is variable as illustrated by the following records: forms part of the undergrowth in riverine bush; in grassland against slopes of hills (Krantzkop, KwaZulu-Natal); in a very dry and stony habitat on shale (Komga); next to the road on stony red loam (Itala Nature Reserve); between forest trees (Ubombo Mountain Pass);in mixed *Combretum apiculatum*-veld (Jozini); in savanna (Mbabane); in dense savanna against steep, rocky north facing slopes (White River); on lime stone (Strydpoort). *Flowering time*: end of November to January. Fruits ripen in April. *Common names*: makosikate (*Miller S254,* PRE). Ama-kosikate, manohani, mokoele and pypsteel (Moldenke 1958b); Cape vitex, white vitex, Kei finger-leaf (English); Keivingerblaar (Afrikaans). *Utilisation*: wood is seldom used due to the availability of stronger wood types.

Vouchers: *Bredenkamp 208, 261* (topotype) (PRE, PUC); *Brown & Shapiro 347* (PRE); *Codd 4734* (PRE, SRGH); *Flanagan 578* (PRE); *Gerstner 3706* (NH); *Miller S254* (PRE).

9b. subsp. **wilmsii** *(Gürke) C.L. Bredenkamp & D.J. Botha* in South African Journal of Botany 59: 619 (1993).

Types: Transvaal [Mpumalanga]: Bei Lydenburg, Dezember 1895, fruchtend, *Wilms 158* (Z, lecto.!, fide Bredenkamp & Botha (1993); BM!, G!, K!, P!).

V. wilmsii Gürke var. *wilmsii*, Gürke: 76 (1900); H.Pearson: 216 (1901); W.Piep.: 74 (1928); Worsd.: 501 (1941); Moldenke: 122 (1949); Moldenke: 224 (1958b); Moldenke: 54 (1959); Moldenke: 258 (1971b); Palmer & Pitman: 1961 (1973); Coates Palgrave: 812 (1977).

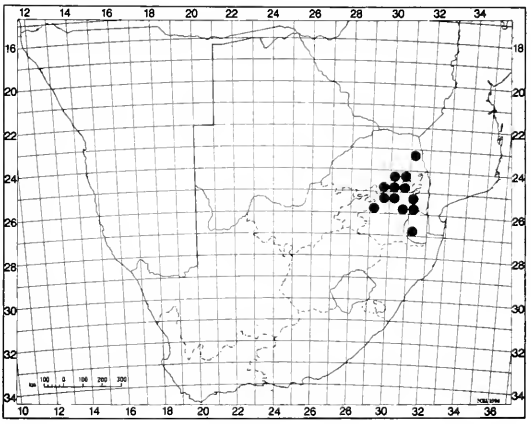

FIGURE 8.—Distribution of *Vitex obovata* subsp. *wilmsii* in southern Africa.

Trees (2–)3–4(–9) m high; young stems and growing points white-tomentose. *Leaves* palmately compound with 3–5 pinnae; petiole (16–)30–35(–72) mm long, white-pubescent; petiolule (0–)3–4(–13) mm long, white-pubescent; median pinna (43–)73–76(–137) × (22–)35–40(–70) mm, elliptic or narrowly obovate, dark green, base acute, apex acute, rounded or mucronate, ad- and abaxial surfaces white-pubescent and glandular. *Inflorescence* a compound dichasium, total length (47–)84–89(–113) mm, white-pubescent; length of bracts at first branch of inflorescence (4–)10–11(–17) mm. Description of flowers and fruit as for subgenus. Figure 7.

Distribution and habitat: endemic to SE parts of the Northern Province, N parts of Gauteng, Mpumalanga and Swaziland (Figure 8). The habitat of this plant varies, as is illustrated by the following records: against north and south facing slopes on dry stony dolomitic soils (Kaspersnek); against east facing slopes on stony soil in grassland (Karino); in riverine bush in the Crocodile River valley (Nelspruit); on steep west facing slopes in forest (Louw's Creek). *Flowering time*: December to January. Fruits ripen in April. *Common names*: Wilms's vitex, umluthu (Z); ama-khosikate (Sw) (Palmer & Pitman 1972); hairy fingerleaf, hairy vitex (English); harige vingerblaar (Afrikaans).

Vouchers: *Bredenkamp 251, 294* (PRE, PUC); *Burtt Davy 7289* (BM); *Codd 6756* (PRE, SRGH); *Meeuse 9325* (PRE, SRGH); *Thorncroft 13* (PRE).

EXCLUDED SPECIES

Vitex guerkeana H.Pearson non Hiern. is a synonym of *V. pearsonii* W.Piep. (Pieper 1928), a tropical African species.

Vitex mooiensis H.Pearson is a synonym of *Premna mooiensis* (H.Pearson) W.Piep. (Moldenke 1971b).

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INDEX

Bothalia 26,2: 153–158 (1996)

Notes on African plants

VARIOUS AUTHORS

AMARYLLIDACEAE

SHOULD *CRINUM FORBESII* (LINDL.) SCHULT. & SCHULT.F. BE REINSTATED?

Lehmiller (1992) reinstated the name *Crinum forbesii* (Lindl.) Schult. & Schult.f. and criticised Verdoorn's (1962) decision to reject it. However, Lehmiller's long reasoning misses the real issue.

Verdoorn (1962, 1968) described two new species of *Crinum*, *C. delagoense* I.Verd. and *C. paludosum* I.Verd. from Natal and Mozambique, being unable to determine the identity of *Crinum forbesianum* Herb. This name, used by Herbert (1837) and Baker (1881, 1896), was based on *Amaryllis forbesii* Lindl. Lindley (1826) described the species from bulbs collected by John Forbes in Delagoa Bay which flowered at Chiswick near London. No type specimen or drawing exists. Herbert (1837) noted that all Forbes's bulbs had rotted. Although Herbert referred to an unpublished illustration, this too is presumably lost.

Verdoorn clearly pondered for many years on the identity of *Crinum forbesii*. She (1962, 1966) discussed in detail why the newly described *C. delagoense* does not fit Lindley's description of *Crinum forbesii*. In addition she (1966) indicated that Forbes's bulbs could have represented more than one species of *Crinum*. Verdoorn (1966, 1968) described the discovery of a new plant by Mr Gordon McNeil that fitted Lindley's description better than *C. delagoense*. Eventually Verdoorn (1968) described this plant as *C. paludosum*. Her (1968, 1973) reasoning is clear. *Crinum forbesii* should be regarded as a *nomen incertum* since it is impossible to prove beyond reasonable doubt that McNeil's discovery represents the same species of *Crinum* as discovered by Forbes.

Lehmiller (1992) appears to have misunderstood Verdoorn and concentrated on the fact that Verdoorn (1973: 45) considered *Crinum forbesii* (Lindl.) Schult. & Schult.f. as illegitimate. In fact Verdoorn correctly considered *C. forbesianum* Herb. as an illegitimate name and continued to reject *C. forbesii* as a *nomen confusum*. The synonyms mentioned under *C. delagoense* by Verdoorn (1973), *Amaryllis forbesii* var. *purpurea* Lindl. and *Crinum forbesianum* var. *punicea* should also be regarded as *nomina incerta*. At least three species of *Crinum* occur in Mozambique that could well fit Lindley's and Herbert's descriptions. These are the very variable *C. macowanii* Baker, *C. delagoense* and *C. paludosum*. Lehmiller himself (1992) argues that discrepancies in the above-mentioned descriptions could be attributed to the fact that Forbes's bulbs were cultivated under less than optimal conditions in England. Incidentally Lehmiller refers to the author of the new combination, *C. forbesii* as 'Schultz', but it is Schult. & Schult.f. in *Systema vegetabilium* 7: 864 (Stafleu & Cowan 1985; Smith 1990).

The present Code of Botanical Nomenclature (Greuter *et al.* 1994) provides new facilities to avoid unnecessary name changes in order to promote a stabilized nomenclature. Lehmiller's (1992) argument for reinstating the confused name *C. forbesii*, 30 years after Verdoorn dealt satisfactorily with it, is misplaced and in strong contrast with the aims of the Code.

It remains likely that *C. delagoense* is conspecific with *C. stuhlmannii* Baker from East Africa, perhaps only distinguishable at subspecific level (Nordal 1977). The latter name will have priority if detailed studies confirm this possibility.

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PROTEACEAE

A NEW SPECIES OF *SERRURIA* FROM THE NORTHERN PART OF THE WESTERN CAPE

This unusual new species was discovered by Mrs Bets Schlebusch in 1993 on the family property Sewefontein in the Matsikamma Mountains above VanRhynsdorp in the northern part of the Western Cape. She showed one of the populations to Dr Ivor Jardine who submitted a specimen to the Protea Atlas Project. Further field investigations were not possible until November 1995 when I accompanied Tony Rebelo of the Protea Atlas Project to Sewefontein to examine flowering specimens in their natural habitat and collect the material on which this account is based.

Serruria lacunosa *Rourke* sp. nov., species distinctissima, distinguitur capitulis axillaribus ovoideis, pedunculis glabris perlongis (85–140 mm); perianthiis rectis ante anthesin; stigmatibus clavatis; stylis reflexis post anthesin, et dense puberulis basaliter.

Frutex erectus, 0.5–1.0 m altus, unicaulis. *Rami* molliter sericei, mox glabrescentes. *Folia* bipinnata, molliter sericea, mox glabrescentia, 60–80 × 40–60 mm. *Inflorescentiae* pedunculatae, rami floriferi 3–12 inflorescentias gerentes; pedunculi glabri, graciles, 85–140 mm longi.

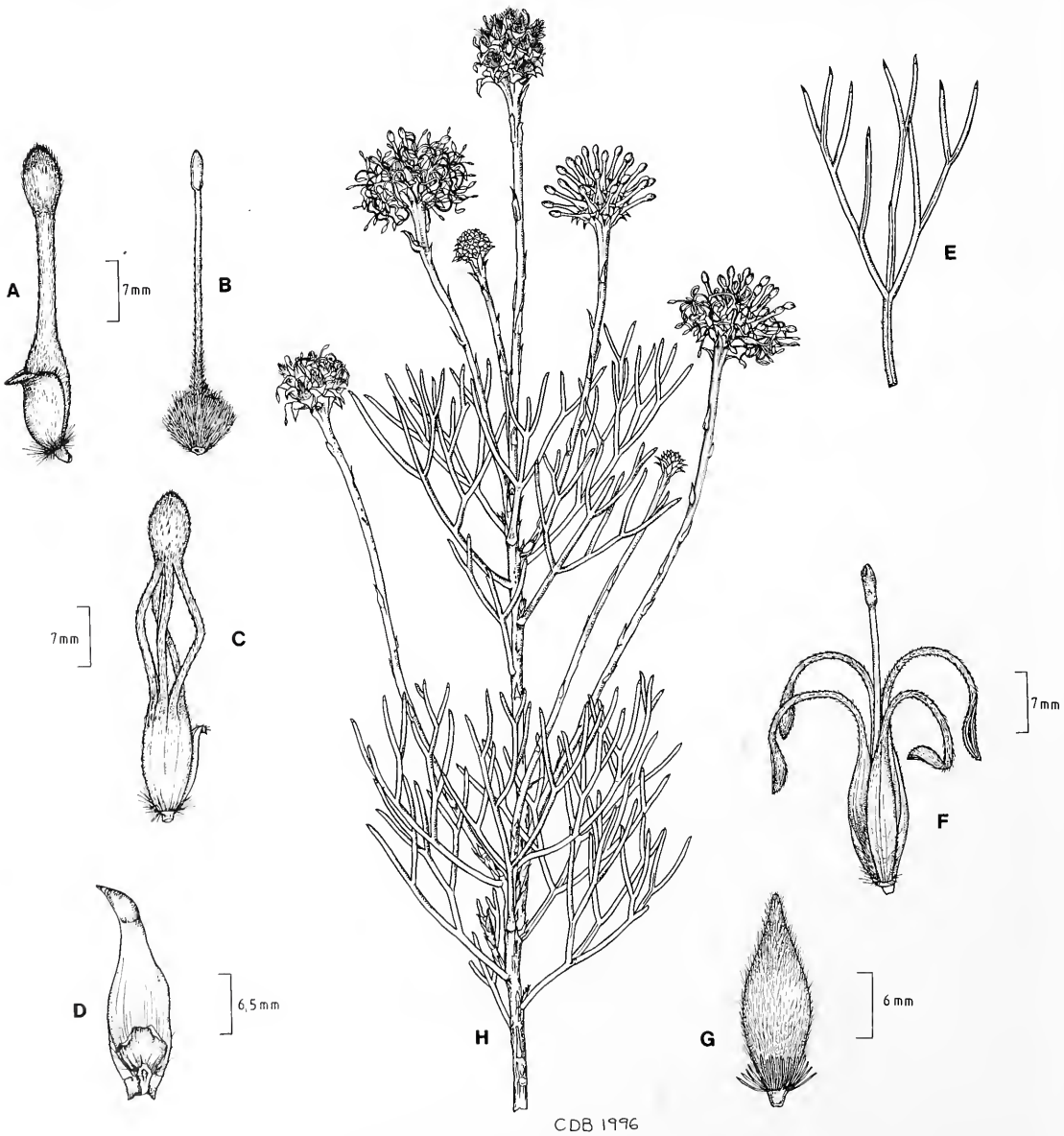

FIGURE 1.—*Serruria lacunosa*: A, perianth in bud plus subtending floral bract; B, gynoecium; C, perianth at anthesis; D, floral bract with thickened apex; E, mature leaf, × 0.6; F, perianth after anthesis; G, achene; H, flowering shoot, × 0.6. All from *Rourke 2108*. Artist: Charmaine Bartman.

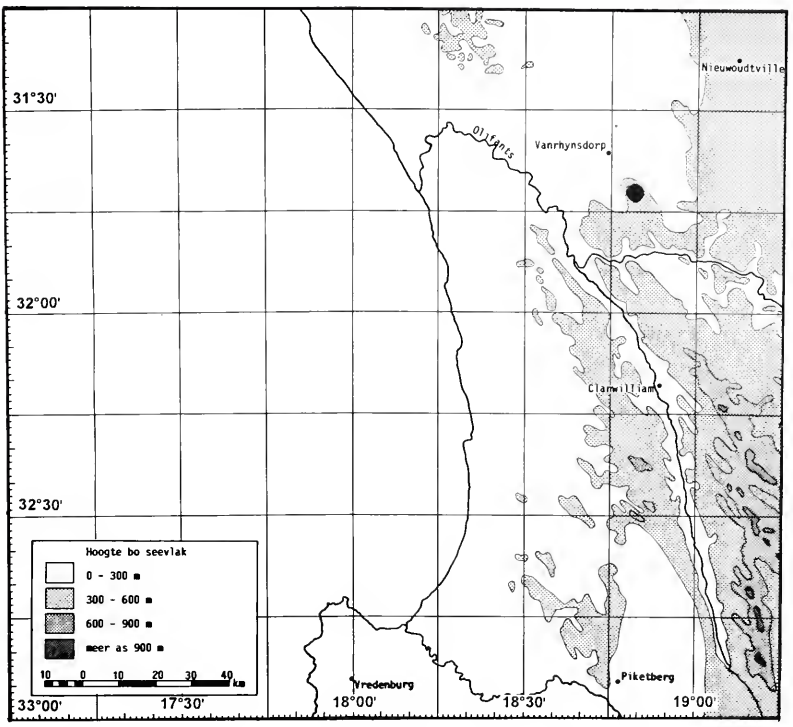

FIGURE 2.—Known distribution of *Serruria lacunosa*.

Capitula axillaria, solitaria, ovoidea, 20–35 mm in diam., floribus 28–35. *Bracteae* anguste ovatae, 5–6 mm longae, 2 mm latae, glabrae, apicibus recurvatis crassis et cartilagineis. *Perianthium* rectum ante anthesin, 12–14 mm longum, sparsim sericeum vel glabrum. *Stylus* rectus, 10–12 mm longus, proximaliter dense puberulus, distaliter glaber. *Stigma* atrum, clavatum, 1.5 mm longum.

TYPE.—Western Cape, 3118 (Vanrhynsdorp): Matsikamma Mtn, on Sewefontein Farm in a kloof southwest of homestead, (–DB), 23-11-1995, *Rourke 2108* (NBG, holo.; BOL, K, MO, NSW, PRE, S, iso.).

Erect, loosely branched shrub 0.5–1.0 m tall, up to 0.7 m in diam., with a single main stem often branched near base, up to 20 mm in diam. *Bark* smooth, greyish brown. *Branches* softly sericeous initially, soon glabrous and reddish flushed, 3–5 mm in diam. *Leaves* bipinnate, softly sericeous initially, soon glabrous, 60–80 mm × 40–60 mm, ascending, petiolate; petiole 20–25 mm long. Leaflets terete, upper surface minutely canaliculate, apices acute. *Flowering shoots* bearing 3–12 pedunculate, solitary, axillary inflorescences, opening in centrifugal succession. *Peduncle* glabrous, slender, 85–140 mm long with a few widely spaced lanceolate-acute, glabrous peduncular bracts. *Inflorescence* a solitary globose axillary capitulum, 28–35-flowered, 20–35 mm in diam. *Receptacle* ellipsoid, 20–25 × 3 mm, with the floral bracts forming a pseudo-involucre at the base. *Floral bracts* narrowly ovate, 5–6 × 2 mm, glabrous, apices cartilaginous, thickened, tooth-like, recurved. *Perianth* straight in bud, 12–14 mm long; tube region 3 mm long, inflated, sparsely sericeous to glabrous; claws equally recurved at anthesis, sericeous; limbs elliptic, 2 mm long, sericeous. *Anthers* 4. *Style* straight at anthesis, 10–12 mm long, reflexing abaxially and pointing towards peduncle in post pollination phase; very densely pubescent, proximally becoming sparsely pubescent and glabrous distally; pubescence covering $^2/_3$ of length. *Pollen presenter* black, clavate-obtuse, 1.5 mm long with a slight annular ring at junction with style; stigmatic groove terminal. *Ovary* globose, sharply differentiated from style, densely lanate. *Hypogynous scales* minute, 1 mm long, deltoid. *Fruit* an ellipsoid, villous achene 6–7 × 2.5–3.0 mm, beaked terminally, truncate and pedicellate basally with a basal fringe of stout trichomes (Figure 1).

Diagnostic characters

Distinguished by its solitary, ovoid, axillary capitula with unusually long (85–140 mm) glabrous peduncles produced in groups of 3–12 towards the upper half of each flowering shoot; by the straight perianth and densely villous styles, pubescent for two thirds of their length which reflex towards the peduncles through almost 180° from anthesis to the post pollination phase and by the clavate pollen presenters.

The specific epithet *lacunosa* (= full of pools) alludes directly to the Matsikamma Mountains where *S. lacunosa* occurs. This Koi-Koi name is generally understood to mean 'pools of water' (Nienaber & Raper 1977); it could also apply to a specific site on Matsikamma, namely the Farm Sewefontein (Seven Springs), which is the type locality of the species.

Relationships

Serruria lacunosa is not obviously related to any other species in the genus although the inflorescence architecture is similar to that in *S. reflexa* Rourke, namely, a

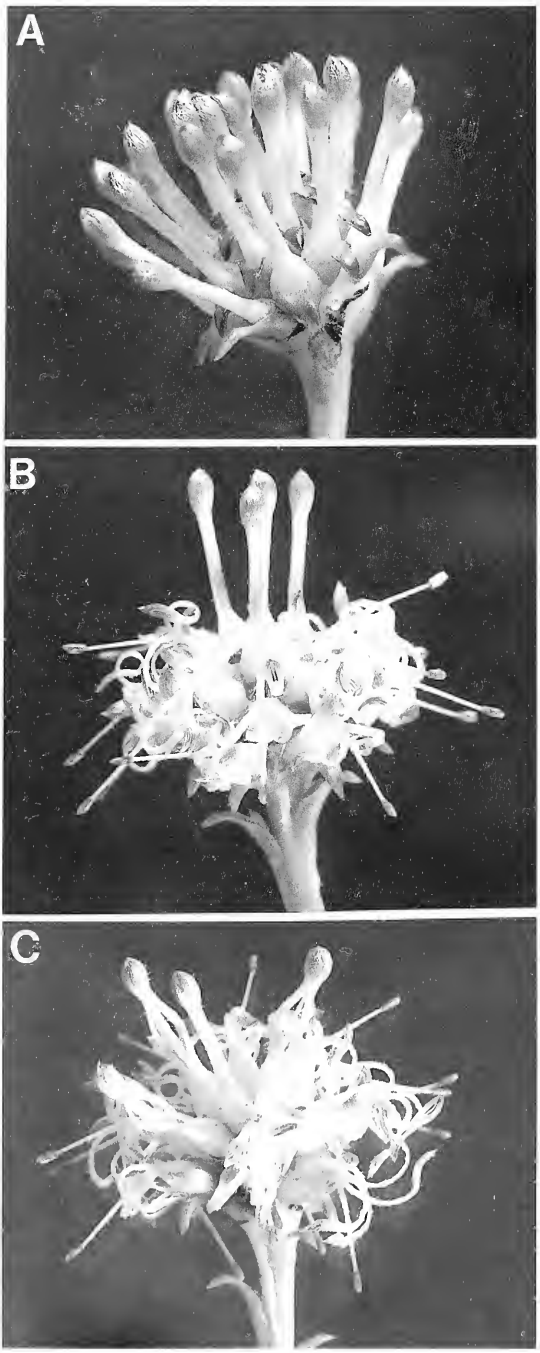

FIGURE 3.—Stages in opening of inflorescence in *Serruria lacunosa* showing movement of styles until they point downwards towards ground: A, bud stage; B, most perianths open, styles spreading but beginning to turn down; C, remaining perianths opening with styles from two earlier opened perianths pointing downwards, parallel to peduncle.

number of solitary axillary capitula with attenuated peduncles grouped towards the apex of a flowering shoot. The mobile style strongly reflexed above the ovary, is also comparable to the style in *S. reflexa* but *S. lacunosa* differs sharply from the former species due to its heavily pubescent style. The styles are glabrous in all other species having straight perianths at anthesis.

After the erect, vertically placed styles spring free of the perianths during the first stages of anthesis when the pollen presenters are still covered in pollen, they move through almost 180° until they point downwards towards the ground. This movement is presumably linked to pollination cues and changes in the receptivity of the stigmatic surface (Figure 3).

Distribution, habitat and conservation status

This species appears to be very rare and is presently known only from the type collection. At the time of writing no more than two populations had been discovered, one consisting of approximately fifteen plants, the other of approximately nine plants. Both populations are within a few hundred metres of each other in undisturbed veld on Sewefontein Farm at the northern end of the Matsikamma Mountain (Figure 2). *Serruria lacunosa* is almost certainly a Matsikamma endemic. While it is probable that other populations exist in the same general area, it seems unlikely that this species ranges beyond its specialised habitat in the northern Matsikamma massif. Several one- to two- year-old seedlings were observed on bare patches of soil between the parent plants indicating its ability to regenerate without the intervention of fire.

The two populations examined are situated at an elevation of about 750 m in a gently sloping gully flanked by high Nardouw Sandstone Cliffs of the Table Mountain Group (Kent 1980). Unlike the typically coarse-grained soils usually derived from sandstone, the soil at this site is white, very fine-grained and clay-like in consistency. The associated vegetation consists mainly of dense clumps of *Hypodiscus laevigatus* (Kunth) Linder (Restionaceae). Mean annual rainfall at this site is of the order of 500 mm (D. Schlebusch pers. comm.).

Flowering apparently extends over a period of at least four months or longer, peaking between September and December but continuing until February. Odd open inflorescences have been reported as late as April. This is due to the slow development of the inflorescence buds which open successively towards the end of each flowering shoot in centrifugal order. The inflorescences have no perceptible scent. When the type material was collected in early summer (November) numerous hairy scarab beetles were observed clambering over open inflorescences apparently feeding on pollen (very little nectar is produced in this species). This particular scarab (*Peritrichia antennata* Schein, Scarabaeidae) is likely to be a seasonally important pollinator but other pollinators may be active at other times during the extended flowering period.

ACKNOWLEDGEMENTS

Mr and Mrs D. Schlebusch kindly granted permission to collect specimens of *S. lacunosa* on their farm. Mrs Schlebusch also collected fruiting material from which mature achenes were later obtained.

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CAMPANULACEAE

TRANSFER OF ELEVEN VARIETIES OF *LIGHTFOOTIA* NOM. ILLEG. TO *WAHLENBERGIA*

In his recent paper, Lammers (1995) transferred 39 southern African species of *Lightfootia* nom. illeg., listed by Welman (1993), to *Wahlenbergia* nom. cons. Some *Lightfootia* species which also occur in tropical Africa, had previously been transferred to *Wahlenbergia* by Thulin (1975). Eleven varieties of *Lightfootia*, all described by Adamson (1955), most of them from the winter rainfall area in South Africa, have not yet been transferred to *Wahlenbergia*. Although it may prove later that varietal status in some or all cases is not warranted, it is however, now necessary to transfer these varieties to *Wahlenbergia* as well.

8668000-03075 **Wahlenbergia denticulata** *(Burch.) A.DC.* var. **transvaalensis** *(Adamson) W.G.Welman* comb. nov.

Lightfootia denticulata (Burch.) Sond. var. *transvaalensis* Adamson: 172 (1955). Holotype: Johannesburg, *Moss 9515* (BOL).

8668000-06350 **Wahlenbergia longifolia** *(A.DC.) Lammers* var. **corymbosa** *(Adamson) W.G.Welman* comb. nov.

Lightfootia longifolia A.DC. var. *corymbosa* Adamson: 177 (1955). Holotype: Cape Peninsula, Klaver Valley, *Moss 7499* (BM).

8668000-10730 **Wahlenbergia rubens** *(H.Buek) Lammers* var. **brachyphylla** *(Adamson) W.G.Welman* comb. nov.

Lightfootia rubens H.Buek var. *brachyphylla* Adamson: 188 (1955). Holotype: Swellendam, Potteberg, *Adamson 4798* (BOL).

8668000-10770 **Wahlenbergia rubioides** *(Banks ex A.DC.) Lammers* var. **stokoei** *(Adamson) W.G.Welman* comb. nov.

Lightfootia rubioides Banks ex A.DC. var. *stokoei* Adamson: 164 (1955). Holotype: *Stokoe s.n.* (SAM *63249*).

8668000-12360 **Wahlenbergia subulata** *(L'Hér.) Lammers* var. **congesta** *(Adamson) W.G.Welman* comb. nov.

Lightfootia subulata L'Hér. var. *congesta* Adamson: 162 (1955). Holotype: Swellendam, Infanta, *Adamson 4812* (BOL).

8668000-12380 **Wahlenbergia subulata** *(L'Hér.) Lammers* var. **tenuifolia** *(Adamson) W.G.Welman* comb. nov.

Lightfootia subulata L'Hér. var. *tenuifolia* Adamson: 161 (1955). Holotype: Paarl, Franschhoek Pass, *Adamson 4911* (BOL).

8668000-12530 **Wahlenbergia tenella** *(L.f.) Lammers* var. **palustris** *(Adamson) W.G.Welman* comb. nov.

Lightfootia diffusa H.Buek var. *palustris* Adamson: 193 (1955). Holotype: Swellendam, Tradouw Pass, *Adamson 4821* (BOL).

8668000-12540 **Wahlenbergia tenella** *(L.f.) Lammers* var. **stokoei** *(Adamson) W.G.Welman* comb. nov.

Lightfootia diffusa H.Buek var. *stokoei* Adamson: 194 (1955). Holotype: Caledon, Palmiet River, *Stokoe 8658* (BOL).

8668000-12570 **Wahlenbergia tenerrima** *(H.Buek) Lammers* var. **montana** *(Adamson) W.G.Welman* comb. nov.

Lightfootia tenella Lodd. var. *montana* Adamson: 199 (1955). Holotype: Swartberg Pass, *Adamson 4889* (BOL).

8668000-13080 **Wahlenbergia uitenhagensis** *(H.Buek) Lammers* var. **debilis** *(Sond.) W.G.Welman* comb. nov.

Lightfootia divaricata H.Buek var. *debilis* (Sond.) Adamson: 182 (1955). Holotype: Uitenhage, Winterhoek, *Zeyher 3131* (S).

8668000-13085 **Wahlenbergia uitenhagensis** *(H.Buek) Lammers* var. **filifolia** *(Adamson) W.G.Welman* comb. nov.

Lightfootia divaricata H.Buek var. *filifolia* Adamson: 183 (1955). Holotype: Uitenhage, Swartkops River, *Zeyher s.n.* in herb. Sonder (S).

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ASPHODELACEAE

GENERIC NUMBERS IN THE SUBFAMILY ALOOIDEAE

In *Plants of southern Africa: names and distribution* (Arnold & De Wet 1993), three alooid genera (family Asphodelaceae subfamily Alooideae) are recognized in the region. In future publications resulting from the PRECIS database (Smith *et al.* 1995), this number will be expanded to six (*Aloe* L., *Astroloba* Uitewaal, *Chortolirion* A.Berger, *Gasteria* Duval, *Haworthia* Duval and *Poellnitzia* Uitewaal). One of these, the monotypic *Poellnitzia*, was recently treated (Smith 1995) in the new series, '*FSA* contributions', in *Bothalia*. In this paper its generic number was given as 1028010. Originally (De Dalla Torre & Harms 1900–1907), the number 1028 was allotted to the genus *Apicra* Willd. [non Haw.] (Reid & Glen 1993). For nomenclatural reasons (Smith *et al.* 1994) this genus was renamed *Astroloba* by Uitewaal (1947). Since *Astroloba* is therefore biologically identical to *Apicra*, it should best be allotted the first derivative number, namely 1028010. *Poellnitzia* and *Astroloba*, both previously treated as synonyms of *Haworthia*, will in future be upheld as distinct genera (at least by PRE). To prevent confusion, the full PRECIS citations for these three haworthioid genera are proposed as:

1028000 *Apicra* Willd. = Haworthia

1028010 Astroloba *Uitewaal*

1028020 Poellnitzia *Uitewaal*

The remaining southern African alooid genera are then, alphabetically:

1026000 Aloe *L.*

1029010 Chortolirion *A.Berger*

1027000 Gasteria *Duval*

1029000 Haworthia *Duval*

The only remaining alooid genus which is currently, but doubtfully upheld, *Lomatophyllum* Willd., is a Madagascan and Mascarene endemic and does not occur in continental southern Africa. It has the number 1030 (De Dalla Torre & Harms 1900–1907).

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Exormotheca bulbigena sp. nov. (Hepaticae, Marchantiales) and its relation to *E. holstii* in southern Africa

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Keywords: *Exormotheca bulbigena, E. holstii*, Hepaticae, Marchantiales, southern Africa

ABSTRACT

A new species *Exormotheca* **bulbigena** is described from southern Africa and its relation to *E. holstii* Steph. is discussed. Morphologically these species are very similar and can be distinguished only when fertile. The chromosome numbers, however, n = 32 for *E.* **bulbigena** and n = 18 for *E. holstii*, distinguish sterile living plants.

INTRODUCTION

Stephani (1899), in his *Species hepaticarum*, described a new species, *Exormotheca holstii*, from Muse (Tanzania). Subsequently, Marquand (1930), apparently unaware of Stephani's publication, described *E. megastomata* from a site near Middelburg, Mpumalanga (Transvaal), South Africa, as a new species. Finally Arnell (1953) published a new species, *E. youngii*, from Pilgrim's Rest, Mpumalanga, (Transvaal) South Africa, which he himself later placed in synonymy under *E. holstii* in 1963. After a morphological examination of all the respective herbarium samples Perold (1994) sank *E. megastomata* under *E. holstii.*

Chromosome numbers of *Exormotheca* samples from the *loci classici* of Marquand and of Arnell and from other sites in eastern Africa as well, always yielded a chromosome number of n = 18. However, *Exormotheca* plants collected by Volk at Gaikos and Otjua in Namibia have a chromosome number of n = 32. Nevertheless, all other morphological characters of the sterile plants were identical to those from the eastern sites. *A priori*, different chromosome counts cannot be considered as distinctive on species level, because there are many different species in the Marchantiales with the same chromosome number. On the other hand, some species with as many as six different caryotypes are also reported (Bornefeld 1989; Fritsch 1982).

By cultivation in a greenhouse, Volk succeeded in growing fertile plants from material collected in the eastern localities and in Namibia. The present study is based on the examination of living and fertile plants, and only those specimens are considered for which the chromosome number and/or the spores are known. The study of the sexual organs and their products and the asexual reproduction of *Exormotheca* has shown that the sinking of *E. megastomata* under *E. holstii* (Perold 1994) is justified. However, an additional new species, *E. bulbigena*, has to be established.

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MATERIALS AND METHODS

Dry herbarium samples of *Exormotheca* from southern Africa were cultivated in a greenhouse on a mixture of garden mould and sand over a base of peat.

For chromosome counts, thallus tips were fixed, extracted and stained with orceine as described earlier (Bornefeld 1984). In the present study only samples with known chromosome numbers are considered, although the number of *Exormotheca* localities is far greater (Perold 1994).

The localities are listed according to Edwards & Leistner (1971).

For SEM studies the samples were fixed in a mixture of 70% ethanol/glacial acetic acid/40% formalin = 90/5/5 v/v/v at room temperature for 24 hrs, and then dehydrated in an acetone series. After critical point drying with CO_2 and sputtering with gold, SEM micrographs were taken with a DSM 962 model by Zeiss.

Exormotheca bulbigena *Bornefeld, O.H.Volk & R.Wolf*, sp. nov.

Thallus monoicus. Frons hyalina, usque ad 20 mm longa, simplex vel furcata, linearis, antica plana, crassa. *Costa* maxima, strato antico aequialta, postice valde rotundata, lateribus convexo-adscendentibus. *Squamae* posticae magnae, cellulis longissimis (50–600 µm) formatae, uno latere ad basin grosse lacinulatae, oblique oblongae acuminatae obtusae. *Stratum anticum* costae aequialtum, in fundo fila aggregata gerens. *Stomata* densissima, altissima, ad 2/3 coalita, tertio supero libera, cylindrica, obtusa, vertice poro oblongo (± 50 × 140 µm) perforata. Frons ad apicem stolonum bulbillos pulviniformes ± 2–4 mm longos et latos 2–3 m altos gerens. Antheridia minuta in duabus lineis (30 × 40 µm) caudaliter et sagittaliter carpocephali, in strato antico, stomatibus contecta, disposita. *Ostiola* ± 160 µm lata, e sulco prominentes. *Carpocephala* in fundo alveoli nudis, strato antico recedente et ante di-

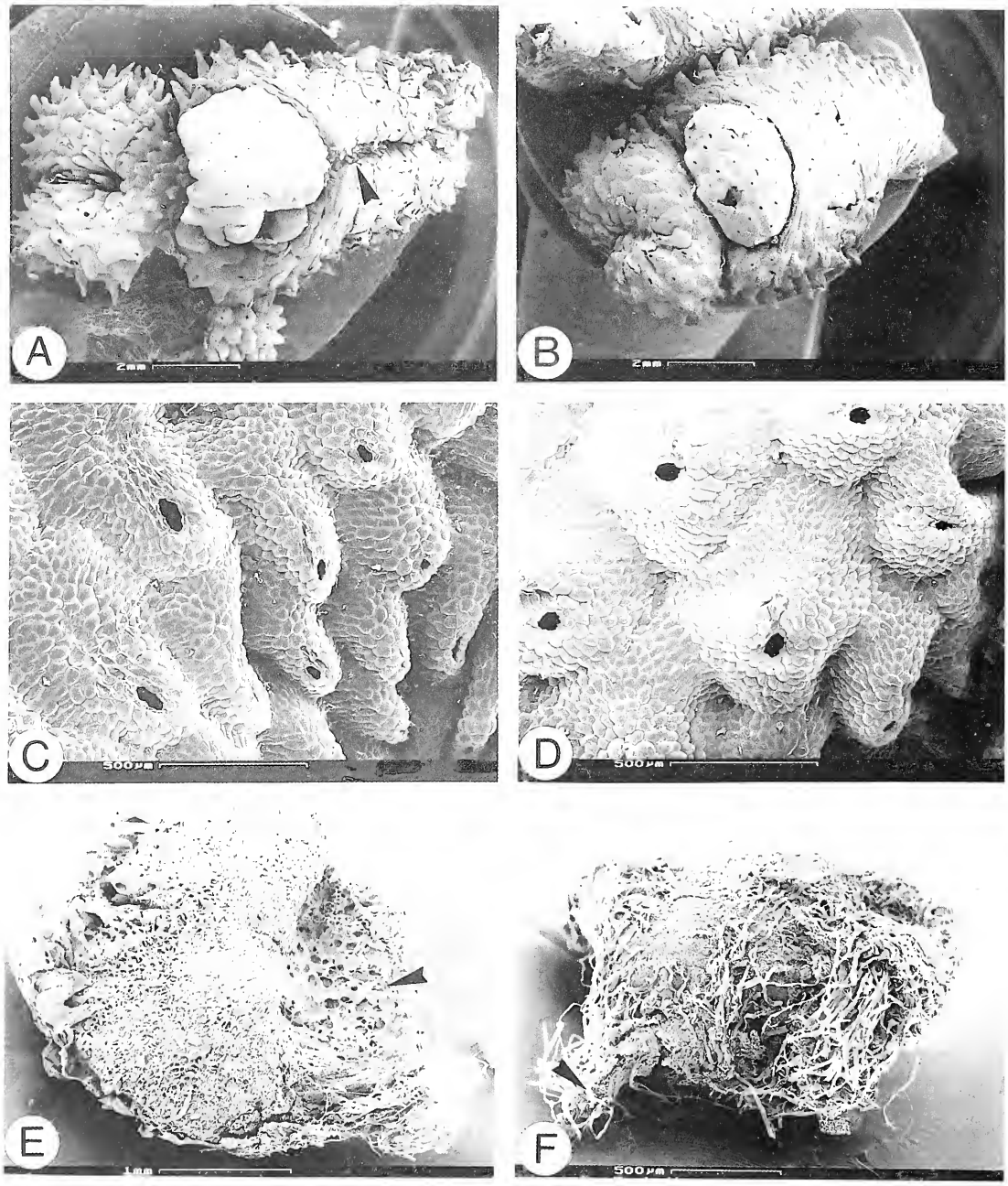

FIGURE 1.—*Exormotheca bulbigena*: A, thallus with carpocephalum; arrow shows antheridial necks. C, stomata with pores. E, F, bulb: E, dorsal view, where surface is broken (arrow), spongy interior tissue is visible; F, ventral view, arrow shows remnant of stolon which formed bulb. *E. holstii*: B, female thallus. D, stomata with pores near thallus tip. Scale bars: A, B, 2 mm; C, D, 500 µm; E, 1 mm; F, 500 µm.

chotomiam frondis. Complura carpocephala sequentialiter et aequidistantes (± 3–4 mm) in una frons inserta esse possunt. *Receptacula* sessilia globosa, vertice haud porosa stratoque chlorophyllifero tecta; subtus obconico-angustata, utroque latere involucrata; *involucra* 2, opposita, capituli vertice convexo-prominente separata, oblique adscendentia, conchaeformia, antice subcarinata, subtus apiceque aperta, labiis late hiantibus usque ad basin decurrentibus; *capsula* longius pedicellata, irregulariter quadrivalvata, valvae rufo-brunneae, maxime incrassatae. *Sporae* ± 140 µm, papulae distales irregulariter vermiculiformes. *Elateres* degeneratae (20 µm latae et 50–150 µm longae) cum anulis et spiralibus brevibus. *Chromosomatum numerus*: n = 32.

TYPE.—Namibia, 2216 (Otjimbingwe) Farm Otjua, granitic outcrop, (–AA), *Volk 85/766* c. fr. (M, holo.; M, PRE).

DISCUSSION

In her study of *Exormotheca holstii* samples from southern Africa, Perold (1994) necessarily used dry material from various localities collected in different years. In our studies, samples of *E. holstii* from Namibia and Mpumalanga (eastern Transvaal) and of *E. bulbigena*, grown under identical conditions, developed carpocephala (Figure 1A, B). Other characters such as overall size and shape, shape in cross-section, cell shape of the assimilatory tissue, width and height of the stomata [the papillae on top of (or) side of which stomata are located], shape of the ventral scales, and colour were all the same. Because these characters are meticulously described by Perold (1994) they are not repeated here, where the differences between the two species are emphasized. The only morphological feature which differs in the sterile thalli are the pores of the stomata; they are more elongate in *E. bulbigena* than in *E. holstii* (Figure 1C, D; Table 1). Whether or not these relations are affected by ecological factors in the field is unknown and therefore these differences should not be overestimated.

The formation of small bulbs is known for *E. tuberifera* (Kashyap 1914) and for *Corbierella* (= *Exormotheca*) *algeriensis* Douin & Trabut (1919). Therefore we investigated our cultures for such organs and indeed found these in *E. bulbigena* (*inde nomen*). They are cushion-shaped, 2–4 mm long and broad, and 2–3 mm thick. The bulbs consist of a chlorophylliferous, spongy tissue with some oil cells, somewhat more compact ventrally. When mature these little bulbs are no longer attached to the thallus and occur isolated in the ground. When dry they shrivel up and are easily overlooked in the field. Figure 1E & F shows the dorsal and ventral view of bulbs which were rehydrated for one day after seven months of desiccation. On the lower side the remnant of the stolon which formed the bulb is visible (arrow). *Exormotheca holstii* also forms short stolons with a slightly enlarged terminal bud, but these are not drought tolerant and upon remoistening become covered by mould.

As there appears to be little variation in the caryotype, the main character for discrimination of sterile plants remains the chromosome number: n = 32 for *Exormotheca bulbigena* and n = 18 for *E. holstii* (Figure 2A, C). Chromosome analysis (Bornefeld 1984) reveals that *E. bulbigena* is eutetraploid to a basic number of eight chro- mosomes and *E. holstii* is eudiploid to a basic number of nine chromosomes (Figure 2B; D). The difference in the basic numbers is not surprising when taking into account that for *Exormotheca fimbriata* (Brazil) both caryotypes are reported: n = 8 (Jovet-Ast 1976) and n = 9 (Bornefeld unpubl.).

TABLE 1.—Size relations of stomatal pores of *Exormotheca bulbigena* and *E. holstii* grown simultaneously under identical conditions (n = 16)

	E. bulbigena	*E. holstii*
long axis	138.1 ± 37.9 µm	127.8 ± 24.6 µm
short axis	52.9 ± 20.1 µm	88.1 ± 13.6 µm
long axis : short axis	2.61	1.45

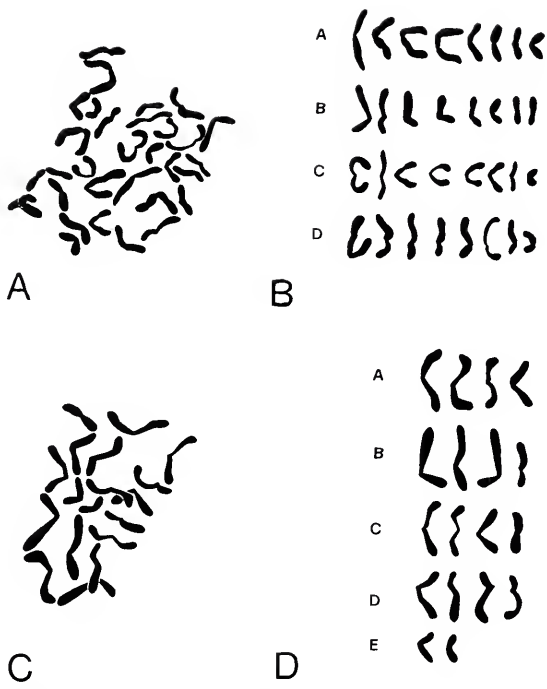

FIGURE 2.—*Exormotheca bulbigena*: A, original arrangement of chromosome set; B, chromosomes sorted by types. *E. holstii*: C, original arrangement of chromosome set; D, chromosomes sorted by types.

The type of *Exormotheca holstii* is dioecious; the types of Marquand (1930) and of Arnell (1953) are sterile. In our cultures out of 12 samples from South Africa only one contained both sexes; four were female, three were male, and four remained sterile. When comparing fertile plants of *E. bulbigena* and *E. holstii* the most obvious difference is the deep sulcus caudal to the carpocephalum of the monoecious *E. bulbigena* (Figure 1A) which is lacking in the female *E. holstii* plant (Figure 1B). Closer inspection of the sulcus shows the antheridial necks which are composed of eight rows of cells (Figure 3A). The whole structure has a diameter of ± 160 µm. The antheridial necks of *E. holstii* (Figure 3B, D) have a diameter of only 100 µm. A series of sagittal sections of the carpocephalum of *E. bulbigena* (Figure 4A, B) reveals the presence of two rows of additional 'microantheridia' 40 × 30 µm; the respective values for the main antheridia in the depth of the sulcus, which are arranged in two parallel rows, are 350 and 150 µm. These microantheridia are a unique feature not described as yet for liverworts. The reinforcing bands in the sporangium wall are very variable within one sporangium and thus are of no value for distinguishing between the two species. The spores of both species are about the same size (120–150 µm), dark brown to black, anisopolar, without a wing. The ornamentation of the distal face of *E. bulbigena* can be described as 'vermiculate' (sensu Perold 1989) (Figure 5A). If the ridges become very short (e.g. Perold 1994, fig. 6A) it can form a papillate pattern. The corresponding structure of *E. holstii*, very broad, indented papillae, could be described as 'polygonal'. Figure 5C shows a spore of the sample *Crosby 1115* from Zoetvlei and its similarity to that of the type of *E. holstii* (Figure 5E) proves the cor-

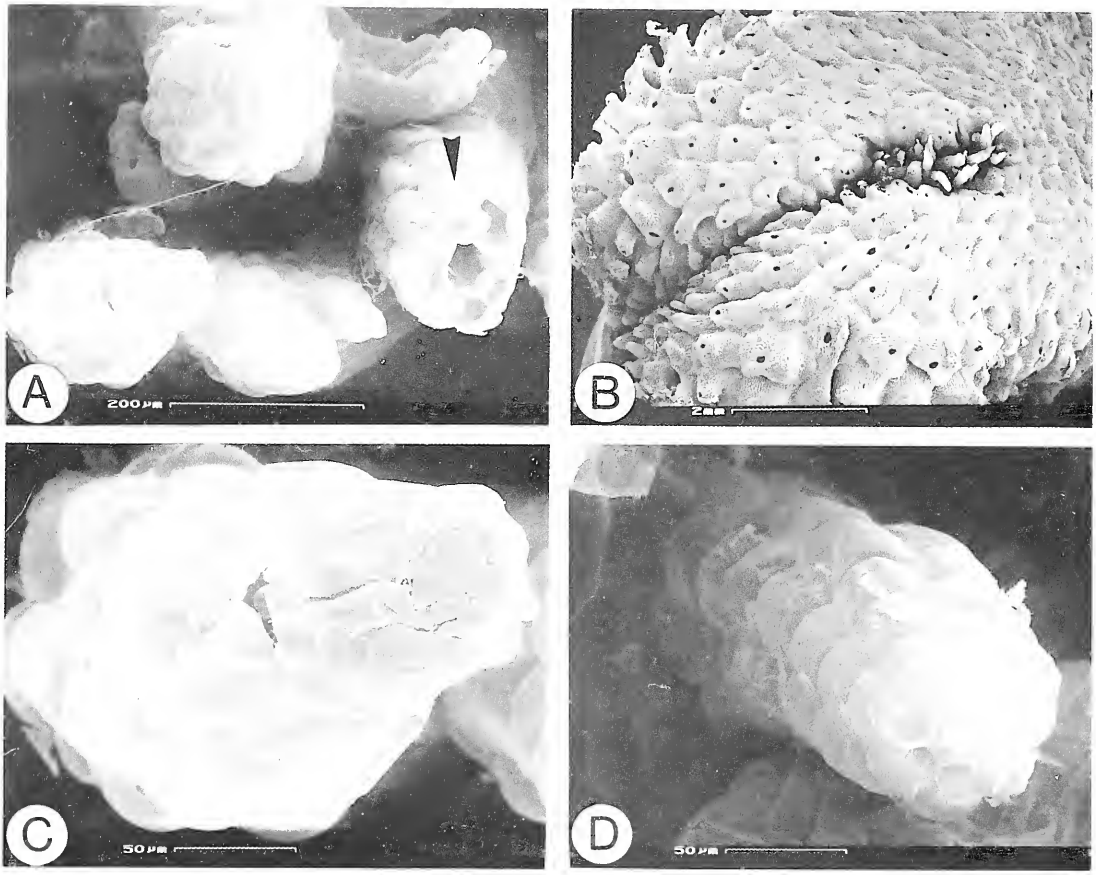

FIGURE 3.—Antheridial necks. A, C, *E. bulbigena*: A, from sulcus, arrow shows broken neck with 8 rows of cells forming the channel. B, D, *E. holstii*: B, male thallus with antheridial necks. Scale bars: A, 200 µm; B, 2 mm; C, D, 50 µm.

rectness of the identification by Perold (1994). In the description of *E. holstii*, with respect to the papillae of the spores, Stephani (1899) mentions 'papulis saepe rostratis'. In Figure 5E no rostrum-like structures can be detected on the papillae and it remains unclear to which structures Stephani refers; elaters stuck to the papillae probably led to the remark mentioned. The ornamentation of the proximal face of the spores is rather fine and the triradiate mark is inconspicuous (Figure 5B, D, F). The differences of the distal face become visible in another way by dark-field microscopy where the spores are seen in a bright orange colour. With this method structures are visible on the ridges of the ornaments which in *E. bulbigena* are punctiform or very short grooves, for *E. holstii* they may be

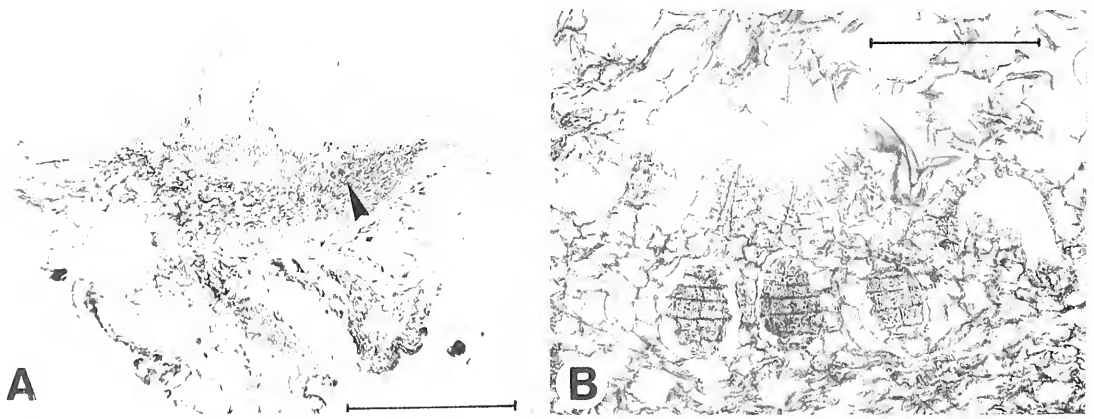

FIGURE 4.—*E. bulbigena*: A, sagittal section through carpocephalum; arrow shows site of microantheridia. B, microantheridia. Scale bars: A, 1 mm; B, 100 µm.

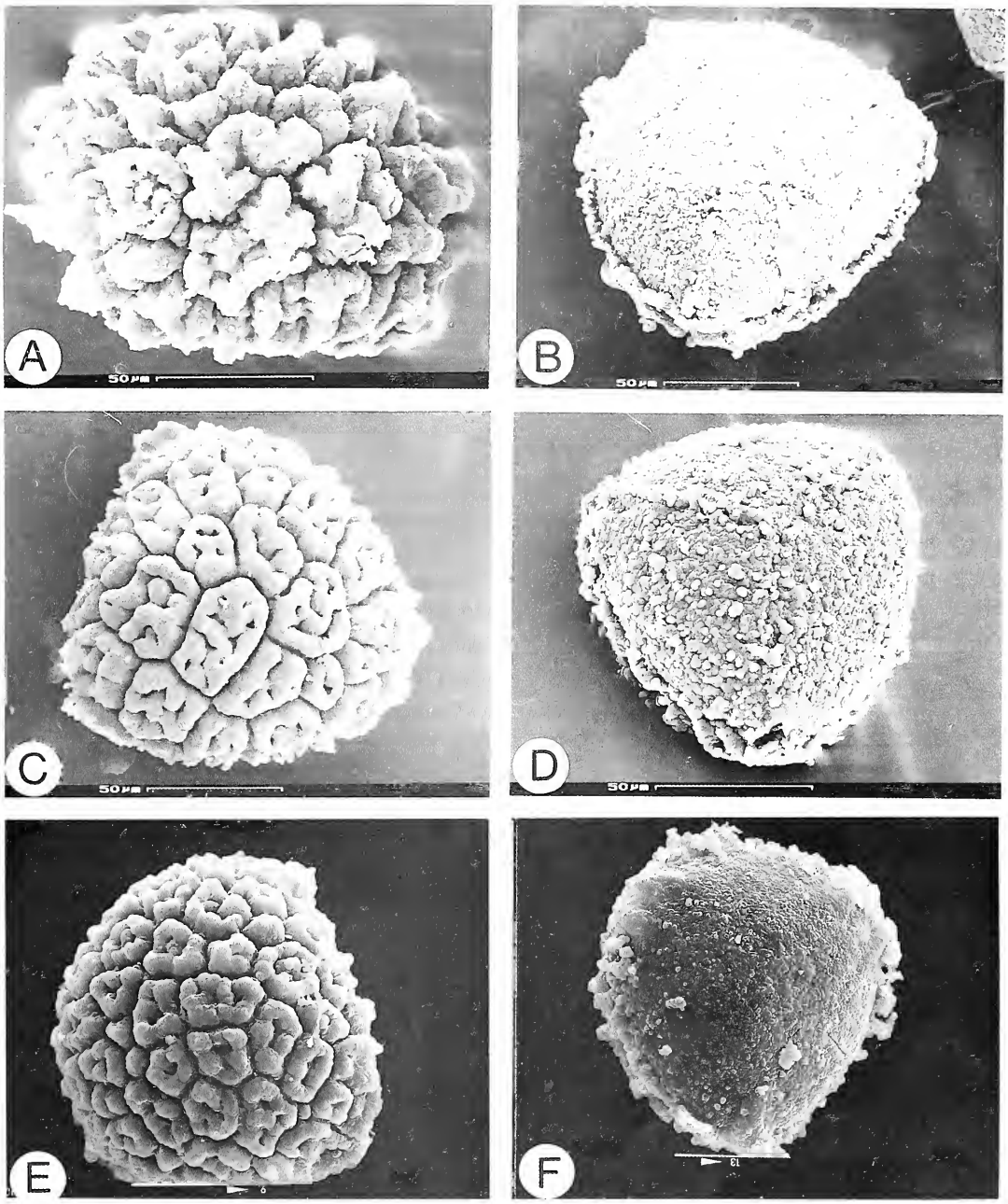

FIGURE 5.—Spores. A, B, *E. bulbigena*: A, distal view; B, proximal view. C–F, *E. holstii*, *Crosby 1115*, Zoetvlei. C, distal view, D, proximal view; E, F, type specimen, E, distal view, F, proximal view. Scale bars: A–D, 50 µm; E, F, 50 µm.

described as long, finely branched furrows (Figure 6A, B). The elaters of both species are degenerate, about 20 µm in diameter and between 50 and 150 µm long, with rings or incomplete spirals. Summarising all the differences between *E. bulbigena* to *E. holstii* (Table 2) we consider it obligatory to consider the former as a distinct species, even though sterile plants are very similar.

Consideration of the climate diagrams (Walter & Lieth 1967) for typical sites of the two species (Figure 7A, B) suggests that *E. bulbigena* is better adapted to a hotter and drier climate than *E. holstii*. The site of the latter at Rietfontein in Namibia is near a fountain and thus not contrary to this suggestion.

The immediate influence of external ecological factors on physiological activity of these plants is difficult to estimate. Both species form droplets of condensed water inside the stomata which consist of living cells. By cooling down the air within the stomata by evaporation and

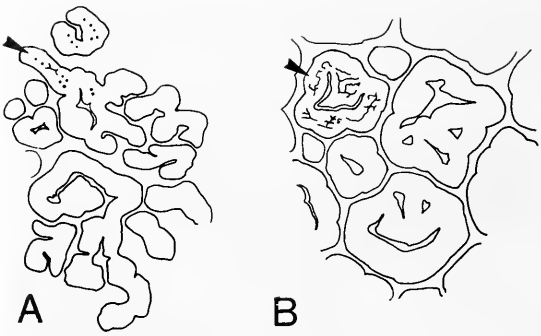

FIGURE 6.—Ornamentation of the distal spore faces as seen by dark-field microscopy. A, *E. bulbigena*; B, *E. holstii*. Arrows: fine structure on ridges of ornaments.

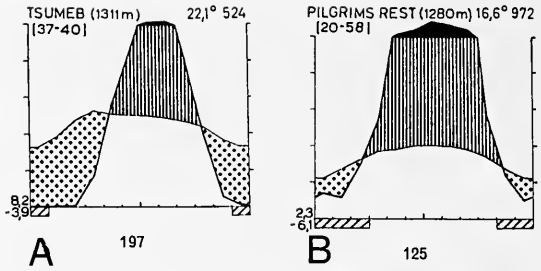

FIGURE 7.—Climatic diagrams of typical sites. A, in Tsumeb, Namibia for *E. bulbigena*; B, in Pilgrim's Rest, Mpumalanga (Transvaal) for *E. holstii*.

TABLE 2.—List of characters differing in *Exormotheca bulbigena* and *E. holstii*

	E. bulbigena	*E. holstii*
sterile plants		
chromosome number	n = 32	n = 18
shape of pores	oblong	shortly elliptical
small bulbs	+	–
fertile plants		
sex distribution	monoecious	dioecious
fertile (female) thallus	with sulcus	without sulcus
spore ornamentation distal face	vermiculate	polygonal
width of antheridial necks	160 µm	100 µm
microantheridia	+	–

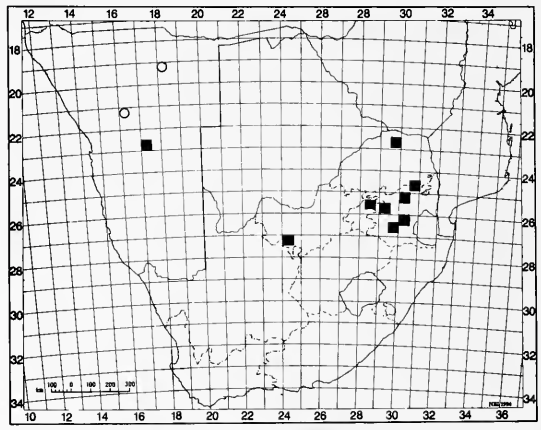

FIGURE 8.—Distribution map of *E. bulbigena*, ○; and *E. holstii*, ■, in southern Africa. Only samples with known spores and/or chromosome numbers were considered.

by their sheltered humidity the plants seem to establish a greenhouse-like microclimate of their own, certainly favourable for photosynthesis. Figure 8 shows the distribution of the two species in southern Africa. So far *E. bulbigena* has only been found in Namibia and may thus be considered endemic to this region.

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We wish to thank Mrs C. Gehrig for excellent work in preparing the SEM samples, Prof. W. Hartung for reading the manuscript, Dr S.M. Perold, NBI, Pretoria, for the loan of the photographs of the spores of the *E. holstii* type, and Mr R. Wacker for the microtomy of the carpocephalum of *E. bulbigena*.

SPECIMENS EXAMINED

Exormotheca bulbigena, n = 32

NAMIBIA.—1918 (Grootfontein): Gaikos, on quartzite sand, (–AD), *Volk 81/124* (M, PRE). 2116 (Otjimbingwe): Otjua, granitic outcrop, (–AA), *Volk 84/696, 85/766, 88/030* (M, PRE).

Exormotheca holstii, n = 18

NAMIBIA.—2217 (Windhoek): Rietfontein, Granitzersatz, durch Sickerwasser zeitweise feucht bis nass, (–CA), *Volk 01160* (B=L, PRE).

NORTHERN PROVINCE.—2229 (Waterpoort): Lokovhela 793 Farm, Soutpansberg, (–DD), *Glen 2650* (PRE).

MPUMALANGA.—2430 (Pilgrim's Rest): on R532 to Bourke's Luck Potholes ± 1 km before coming to SADF Dog Training Centre, on dry sandy slope above stream, between grass, (–DB), *S.M. Perold* 2702 (PRE). 2529 (Witbank): Felsiger Hang über Elefantenfluss, (–CD), *Volk 88/026*. 2530 (Lydenburg): S of Lydenburg, Spitskop, drier ledge above waterfall, (–AB), *Perold & Koekemoer 2872* (PRE). 2629 (Bethal): Ermelo, (–DB), *s.n.* 2630 (Carolina): Knock Dhu Farm, 13 km SE of Lake Chrissie on Lothair road, common on rich black loamy soil, in grassland, (–AD), *Germishuizen 2839* (PRE).

GAUTENG.—2528 (Pretoria): Donkerhoek, 22.5 km E of Pretoria along Pretoria–Witbank Freeway, just beyond road cutting, seepage area, (–CD), *Germishuizen 5624*; *S.M. Perold 2795, 2796*.

NORTH-WEST.—2724 (Taung): Farm Zoetvlei, ± 50 km W of pan, on higher ground, (–AA), *Crosby 1115* (PRE).

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Morphological and biochemical genetic evidence for hybridization in the genus *Centella* (Apiaceae), with notes on phylogenetic and taxonomic implications

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Keywords: allozyme, *Centella*, hybridization, morphology, relationships

ABSTRACT

The main aim of this paper is to explore the occurrence of hybridization in the genus *Centella*. Morphological as well as genetic characters are investigated to confirm the identity of a putative hybrid between *C. triloba* and *C. macrocarpa*. These two independent data sets, one from enzyme electrophoresis and one from morphology, are compared and interpreted by means of cladistic analysis. *Centella glauca* and *C. virgata* were included in the analysis and the effect of hybridization on cladistics is demonstrated. Hybridization gives a new perspective on infrageneric relationships within the genus *Centella*, as it may have obscured discontinuities between previously discrete infrageneric groups.

INTRODUCTION

The subject of hybrids and hybridization has been covered extensively by a number of authors (e.g. Stace 1989; Nason *et al.* 1992), and the influence of hybridization on cladistics has also previously been the subject of detailed analyses (McDade 1990, 1992, 1995). These authors indicated that hybridization significantly affects infrageneric classification because the limits between taxa may become obscured by reticulate evolution. The following facts pointed to hybridization in the genus *Centella*: 1, lack of correlation between characters of species; 2, reported occurrence of putative hybrids in the herbarium record; and 3, the discovery of a putative hybrid initially thought to be a new species. Apart from the two populations of parent species (*C. triloba* and *C. macrocarpa*) and their putative hybrid, one population each of *C. virgata* and *C. glauca* (and an additional population of *C. macrocarpa*) were included in a cladistic study of morphological characters and enzyme data. A second *C. macrocarpa* population was included to compare relationships at the population and species level. *Centella virgata* and *C. glauca* were chosen because of their obvious close relationship to *C. macrocarpa*. *Centella macrocarpa* from the Swartberg Pass and *C. virgata* are reseeders, i.e. plants that are killed by fire and which can only regenerate from seed after fire, whereas all the other populations and species are resprouters, i.e. plants that survive fire by coppicing, and have a slow rate of seed germination. As a result, only a relatively small number of seedlings are added to the populations after each fire. The inclusion of reseeders and resprouters gives the results broader applications in terms of the effects of fire-survival strategy on genetic variation, and also on the circumscription of species in the *C. virgata* group.

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MATERIALS AND METHODS

Herbarium specimens and material preserved in FAA of *Centella triloba*, *C. macrocarpa* and the putative hybrid, as well as *C. glauca* and *C. virgata* were examined and the leaves, fruits and inflorescences were drawn under camera lucida. For microtome sectioning, leaves and mature fruits preserved in FAA were used. Material was embedded in glycol methacrylate (GMA) according to a modification of the method of Feder & O'Brien (1968) as used by Van Wyk & Tilney (1994), who also give the procedures for ultramicrotome sectioning, staining and photography.

Voucher specimens

C. triloba (7): 3418 Simonstown: Kogel Bay, (–BD), *Schubert & Van Wyk 15.*

C. macrocarpa (4): 3322 Oudtshoorn: Swartberg Pass, (–AC), *Schubert & Van Wyk 90.*

C. macrocarpa (7): 3418 Simonstown: Kogelberg, (–BD), *Schubert & Van Wyk 53.*

C. virgata (5): 3320 Montague: Tradouws Pass, nr Barrydale, (–DC), *Schubert & Van Wyk 67.*

C. glauca (5): 3219 Wuppertal: Groot Winterhoek plateau, (–CC), *Schubert & Van Wyk 101.*

Putative hybrid (2): 3418 Simonstown: Kogelbaai, *Schubert & Van Wyk 98.*

Extraction, sample preparation and gel loading methods are described in Van der Bank *et al.* (1995); a Tris-HCl extraction buffer (pH = 7.5) was used. The supernatant was absorbed directly onto paper wicks, and twelve percent starch (Sigma: S-4501) gels were used. Genetic interpretation of enzyme banding patterns was based on the subunit structure and subcellular compartmentalization of the enzymes (Gottlieb 1981, 1982). Locus nomenclature followed Harris & Hopkinson (1976), Soltis & Soltis (1989), Hillis & Moritz (1990) and Shakalee *et al.* (1990). Locus abbreviations, monomorphic loci, enzyme commis-

TABLE 1.—Locus abbreviations, enzyme commission numbers (E.C.No.), optimal buffer systems and pH

Emzyme (loci)	E.C.No.	Buffer	pH
Aspartate aminotransferase	2.6.1.1	Lithium-hydroxide-borate	electrode : 8.1
AAT-1, -2*		Tris-citrate (Cooke & Buckley 1987)	gel : 8.4
Acid phosphatase	3.1.3.2		
ACP-1*		Histidine-citrate (Kephart 1990)	6.5
ACP-2		Morpholine-citrate (Clayton & Tretiak 1972)	6.1
Cytosol aminopeptidase	3.4.11.1	Tris-EDTA-borate (Goncharenko *et al.* 1992)	8.6
CAP-1		Lithium-hydroxide-borate	electrode : 8.1
		Tris-citrate	gel : 8.4
CAP-2*		Morpholine-citrate	6.1
Glucose-6-phosphate isomerase	3.5.1.9	Tris-EDTA-borate (Markert & Faulhaber 1965)	8.6
GPI		Lithium-borate	electrode : 8.0
		Tris-citrate (Ridgway *et al.* 1970)	gel : 8.7
Isocitrate dehydrogenase	1.1.1.42	Histidine-citrate	6.5
IDH*			
Malate dehydrogenase	1.1.1.37	Tris-EDTA-borate (Markert & Faulhaber 1965)	8.6
MDH*			
Peptidase (substrate : leucil-tyrosine)	3.4._._	Tris-EDTA-borate (Markert & Faulhaber 1965)	8.6
PEP-S*			
Peroxidase	1.11.1.7	Lithium-hydroxide-borate	electrode : 8.1
PER		Tris-citrate	gel : 8.4
Phosphoglucomutase	5.4.2.2	Tris-EDTA-borate (Goncharenko *et al.* 1992)	8.6
PGM-1, -2			
6-phosphogluconate dehydrogenase	1.1.1.44	Lithium-borate	electrode : 8.0
PGD*		Tris-citrate	gel : 8.7
Superoxide dismutase	1.15.1.1	Lithium-borate	electrode : 8.0
SOD*		Tris-citrate	gel : 8.7

* monomorphic loci

TABLE 2.—Allele frequencies of polymorphic loci for six *Centella* populations: *C. triloba* (P1); a putative hybrid between *C. triloba* and *C. macrocarpa* (H); *C. macrocarpa* (resprouter, population from Kogel Bay) (P2); and *C. macrocarpa* (reseeder, population from Swartberg Pass) (P3); *C. virgata* (V); and *C. glauca* (G). Allele frequencies with significant differences (P<0.5) among populations are marked with an asterisk

		Populations					
Locus	Allele	P1	H	P2	P3	V	G
AAT-1	A	0.214	0.500	0.600	0.250	0.300	0.875
	B	0.786	0.500	0.400	0.750	0.700	0.125
ACP-2	A	0.143	0.000	0.143	0.250	0.800	0.000
	B	0.857	1.000	0.857	0.750	0.200	1.000
CAP-1	A	0.167	0.000	0.000	0.000	0.000	0.000*
	B	0.833	0.000	0.200	0.000	1.000	0.800*
	C	0.000	1.000	0.800	1.000	0.000	0.000*
	D	0.000	0.000	0.000	0.000	0.000	0.200
GPI	A	0.143	0.500	0.286	0.000	0.000	0.900*
	B	0.000	0.000	0.000	1.000	0.000	0.000
	C	0.857	0.500	0.714	0.000	1.000	0.100*
PER	A	0.000	0.000	0.000	0.000	1.000	0.000
	B	0.000	0.000	0.417	1.000	0.000	0.000*
	C	1.000	1.000	0.583	0.000	0.000	0.000*
	D	0.000	0.000	0.000	0.000	0.000	1.000
PGM-1	A	0.167	0.000	0.000	0.000	0.000	0.167*
	B	0.250	1.000	0.750	1.000	0.000	0.667*
	C	0.583	0.000	0.250	0.000	1.000	0.167*
PGM-2	A	0.357	1.000	1.000	1.000	1.000	1.000*
	B	0.643	0.000	0.000	0.000	0.000	0.000*

sion numbers and buffer system combinations yielding the best results are listed in Table 1.

Data analysis

We used DISPAN (Ota 1993) for phylogenetic analysis of allozyme data by using neighbour-joining and bootstrap methods (1000 replications) and Nei's (1978) genetic distance values. The analysis of allozyme data was executed using BIOSYS-1 (Swofford & Selander 1981). The morphological data as well as the allele frequencies in the different populations were polarized using *C. triloba* as outgroup. It is probably the least derived of all the species included in the study, judged by the shrubby habit and the broad, dentate, dorsiventral leaves, which we consider to be plesiomorphic within the genus. Of these, the dorsiventral leaves are perhaps the most convincing plesiomorphy, as this character state occurs in related genera and in all the basal species of *Centella* (*C. asiatica* and the *C. eriantha* group). All character states of the outgroup were polarised as plesiomorphic. Alleles that were absent from one or more populations, while exhibiting both a low and a high frequency of occurrence in other populations, were treated as binary or multistate characters. Allele frequencies without any obvious discontinuities (such as AAT-1 and ACP-2) were not included in the analysis. Only those frequencies of which the values were obviously low or high, with no intermediate values (low taken as less than 0.3, high taken as 0.5 or more) were polarised. Again, *C. triloba* was used as outgroup. The intermediate states of the GPI A and PGM-1 B alleles were present in the outgroup, so we were unable to polarize these characters (only the one polarity is shown in Table 3). However, reversing this polarity had no effect, neither on the topology nor on the tree lengths or consistency indices, even when the genetic data were analysed separately (Figure 3D, E). Table 2 lists the allele frequencies used to polarize the enzyme characters, as shown in Table 3. These data were analysed using HENNIG86 (Farris 1988). Five to ten individuals were studied in each population except for the hybrid where only two individuals were present at the locality sampled. Despite the small sample size on which allele frequencies for the hybrid were based, we believed that useful results could be obtained because the observed allele frequencies in the other populations were generally either very high or very low.

TABLE 3.—Characters and polarization of character states in *C. triloba* (P1); a putative hybrid between *C. triloba* and *C. macrocarpa* (H); *C. macrocarpa* (resprouter, population from Kogel Bay) (P2); *C. macrocarpa* (reseeder, population from Swartberg Pass) (P3); *C. virgata* (V); and *C. glauca* (G)

Characters and character states	Species and populations	P1	H	P2	P3	V	G
	morphological data						
1		0	1	2	2	2	2
2		0	1	2	2	2	2
3		0	0	1	1	1	1
4		0	1	1	1	1	1
5		0	1	2	2	0	2
6		0	0	2	2	1	2
7		0	0	1	1	1	1
	genetic data						
8		0	1	1	1	1	1
9		0	2	1	2	0	0
10		0	1	1	1	0	0
11		1	2	1	0	0	2
12		0	0	0	2	0	1
13		0	0	1	1	0	0
14		0	0	0	1	1	1
15		0	1	1	1	1	0
16		1	2	2	2	0	2
17		0	2	1	2	0	1
18		0	1	1	1	1	1
19		0	1	1	1	1	1

Characters and polarization of character states using *C. triloba* as outgroup:

1. Leaf type: broad (6–36 mm wide) = 0; narrow (3–5 mm wide) = 1; acicular (approximately 1 mm wide) = 2.
2. Number of teeth on leaf margin: 3(5–11) = 0; 1(–3) = 1; 1 = 2.
3. Presence of petiole: distinguishable from lamina = 0; not distinguishable from lamina = 1.
4. Tissue arrangement in leaf: dorsiventral = 0; isobilateral = 1.
5. Surface sculpturing in fruit: smooth = 0; ribbed = 1; prominently ribbed = 2.
6. Size of fruit: 3–4 × 3 mm = 0; 4.0–5.5 × 4.0 mm = 1.
7. Indumentum of petals: glabrous or villous = 0; glabrous = 1.
8. CAP-1 A: allele present = 0; allele absent = 1.
9. CAP-1 B: allele absent = 2; allele present at low frequencies = 1; allele present at high frequencies = 0.
10. CAP-1 C: allele absent = 0; allele present = 1.
11. GPI A: allele absent = 0; allele present at low frequencies = 1; allele present at high frequencies = 2.
12. GPI C: allele present at high frequencies = 0; allele present at low frequencies = 1; allele absent = 2.
13. PER B: allele absent = 0; allele present = 1.
14. PER C: allele present at high frequencies = 0; allele absent = 1; allele present at high frequencies = 2.
15. PGM-1 A: allele present = 0; allele absent = 1.
16. PGM-1 B: allele absent = 0; allele present at low frequencies = 1; allele present at high frequencies = 2.
17. PGM-1 C: allele present at high frequencies = 0; allele present at low frequencies = 1; allele absent = 2.
18. PGM-2 A: allele present at low frequencies = 0; allele present at high frequencies = 1.
19. PGM-2 B: allele absent = 1; allele present = 0.

RESULTS

Occurrence of hybrids in the herbarium record

Some established species of *Centella* may in actual fact be of hybrid origin, but this is difficult to prove. Only a few herbarium specimens are possible hybrids. *Esterhuysen 16840,* for example, was identified as a hybrid on the label, and the presence of both parents at the same locality [Uniondale Dist., Zitzikamma Mountains near Joubertina (3323 DD)] was noted. Representative specimens of both parents were collected: *C. eriantha, Esterhuysen 16838* (BOL); *C. montana, Esterhuysen 16939* (BOL). Another specimen of a possible hybrid between *C. triloba* and *C. eriantha* is *Pillans 5894* (BOL), from the Noordhoek Mountains (3418 AB).

Hybridization between C. triloba *and* C. macrocarpa

At Kogel Bay we discovered two morphologically intermediate plants in the transitional zone between a population of *C. macrocarpa* and *C. triloba*. Since the plants were morphologically intermediate between the only two *Centella* species present at this site, we concluded that they must be hybrids. Supporting evidence for their hybrid origin is presented below. Different data sets were analysed to obtain a better understanding of character state distributions in the study group.

FIGURE 1.—Comparison of leaves, fruit and inflorescences of *C. triloba*, *C.* hybrid and *C. macrocarpa*. *C. triloba*: A1–A5, leaves; D1, D2, inflorescence; G, fruit. *C.* hybrid: B1–B5, leaves; E, inflorescence; H, fruit. *C. macrocarpa*: C1–C4, leaves; F1, F2, inflorescence; I, fruit. A1, D2, G, *Barker 6091*; A2, *Adamson 4175*; A3, *Ecklon & Zeyher s.n.*; A4, *Compton 13512*; A5, *Stokoe s.n.*; B1, B2, E, H, *Boucher 564*; B3–B5, *Schubert & Van Wyk 98*; C1, *Esterhuysen 32366*, C2, C4, *Zeyher 4901*; C3, *Parker 4262*; D1, *De Vos 1035*; F1, I, *Compton 17587*; F2, *Adamson 4262*. Scale bars: 10 mm.

Morphology

Morphological evidence for hybridization was based on characters of the leaves, petioles and mature fruit of the parent species and the hybrid. Figure 1A–C shows that the leaves of the putative hybrid are intermediate between the parent species in width and in the number of marginal teeth. The leaves are laminar in *C. triloba* and acicular in *C. macrocarpa*. Based on the outgroup method, broad leaves as well as the presence of three or more teeth are polarized as plesiomorphic while narrow and acicular leaves with few or no teeth respectively are considered as the apomorphic character states of these multistate characters (Table 3). Furthermore, in the hybrid and in *C. triloba*, a lamina can be distinguished from the petiole (as in most other Hydrocotyloideae), whereas in *C. macrocarpa*, no differentiation between lamina and petiole is evident. The differentiation of lamina and petiole is considered plesiomorphic whereas the phyllodinous state of the leaves of *C. macrocarpa* is polarized as apomorphic in Table 3. Transverse sections through the lamina and the petiole of the two species and the hybrid (Figure 2) show differences in shape and in the presence of a layer of palisade cells around the entire circumference of the leaf (dorsiventral in *C. triloba*, isobilateral in *C. macrocarpa* and the hybrid). In the petiole this palisade layer is absent. The continuous layer of palisade cells is not as evident in the lamina of the putative hybrid (Figure 2E) as in *C. macrocarpa* (Figure 2F). The leaves of *C. triloba* are clearly dorsiventral (Figure 2D). In Table 3 dorsiventral leaves are thus considered plesiomorphic whereas isobilateral leaves are considered apomorphic (see note under Data analysis). The leaves of *C. virgata* and *C. glauca* are acicular and isobilateral with no differentiation of lamina and petiole. Transverse sections of the petioles and the lamina of *C. triloba*, the hybrid and *C. macrocarpa*, (Figure 2D, G; E, H; F, I) confirm the intermediacy of the hybrid because of the intermediate shape of both the lamina and the petiole. The petiole of *C. macrocarpa* is winged, that of the hybrid is slightly winged and the petiole of *C. triloba* is not winged at all.

Centella macrocarpa and the hybrid have ribbed fruits, but the ribs on the fruits of *C. macrocarpa* are more distinct than those of the hybrid (Figure 2B, C). The fruits of the putative hybrid are intermediate in shape and are polarized as intermediate between the plesiomorphic character state (smooth fruits) of *C. triloba* and the apomorphic character state (distinctly ribbed fruits) of *C. macrocarpa* (Table 3). Ribbed fruits are exceptionally rare, not only within *Centella*, but within the subfamily Hydrocotyloideae as a whole. As a result, virtually any choice of outgroup would lead to the same polarity decision. Furthermore, the fruits of *C. macrocarpa* are much larger than those of the other species and the hybrid (Figure 1G–I) and the relatively large size is considered apomorphic. Smaller fruits are universal in *Centella* and the polarity decision will therefore not be different for any other outgroup. The fruits of *C. virgata* are smaller than those of *C. macrocarpa* and less distinctly ribbed, whereas the fruits of *C. glauca* are particularly large with well pronounced ribs. *Centella triloba* may be andromonoecious

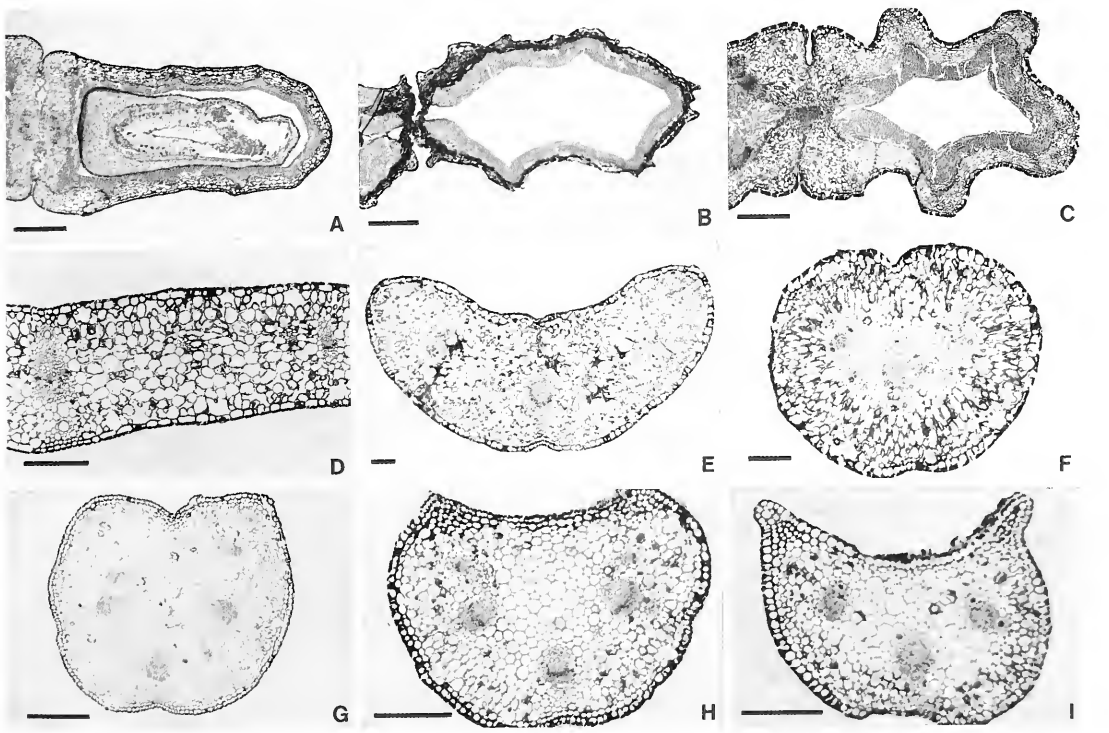

FIGURE 2.—Ultramicrotome sections showing anatomy of leaf lamina, petiole and fruit of *C. triloba*, *C.* hybrid and *C. macrocarpa*. *C. triloba*: A, fruit; D, leaf lamina; G, petiole. *C.* hybrid: B, fruit; E, leaf lamina; H, petiole. *C. macrocarpa*: C, fruit; F, leaf lamina; I, petiole. A, D, G, *Schubert & Van Wyk 15*; B, *Boucher 564*; E, H, *Schubert & Van Wyk 98*; C, F, I, *Schubert & Van Wyk 53*. Scale bars: 0.5 mm.

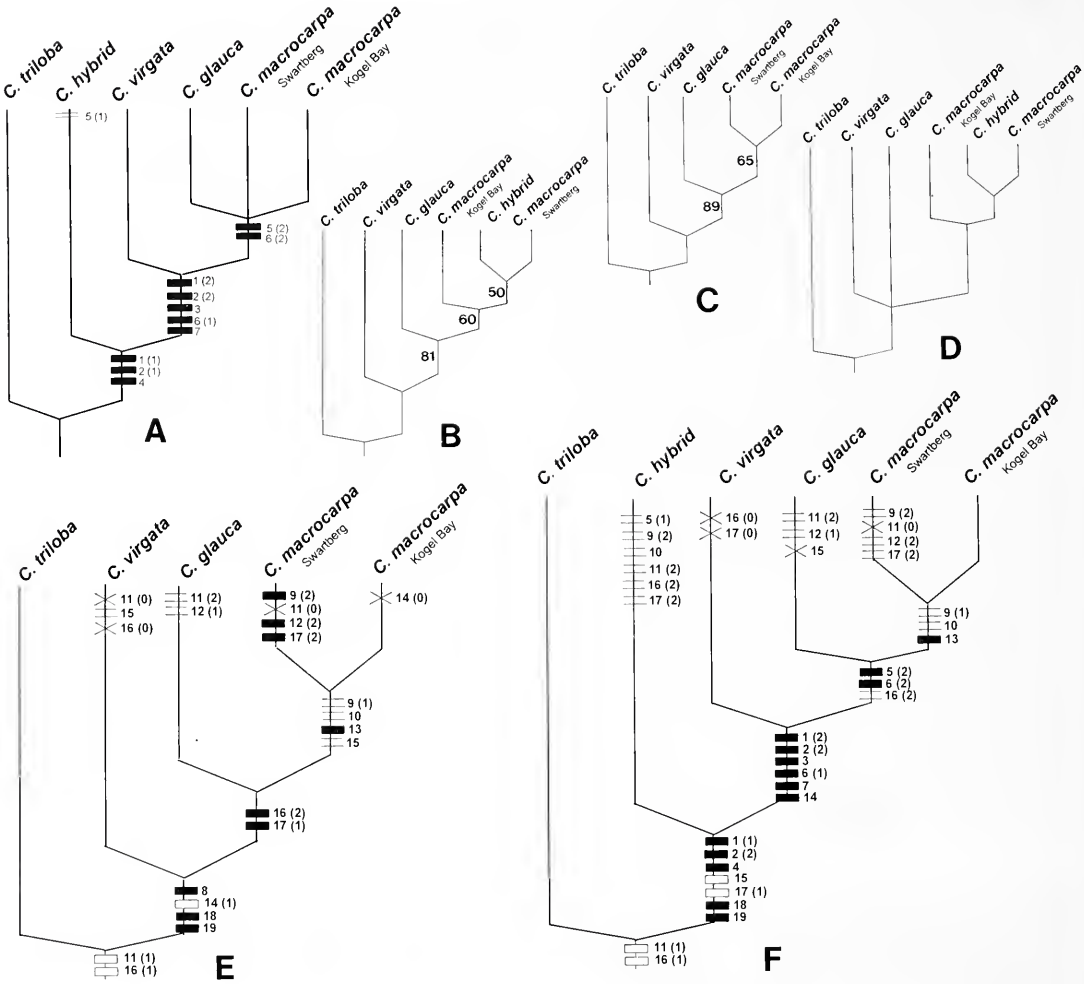

FIGURE 3.—Cladograms and phenograms showing relationships between some species of *Centella*. A, cladogram based on morphological data. B, phenogram, including hybrid, constructed with DISPAN (Ota 1993). C, phylogenetic tree, excluding hybrid, constructed with DISPAN (Ota 1993). D, cladogram, including hybrid, based on genetic data. E, cladogram, excluding hybrid, based on genetic data. F, cladogram based on morphological and genetic data. Characters and polarization of characters used in construction of cladograms listed in Table 3. Solid square, apomorphy without homoplasy; open square, apomorphy with reversal higher up; =, convergence; x, reversal.

(male and bisexual flowers on the same plant but no female flowers) or androdioecious (male and bisexual flowers on different plants and no female flowers) (Figure 1D1, 1D2). The bisexual, functionally female umbellules are made up of a single fruit while the male umbellules have three to five flowers of which the petals occasionally are villous. *Centella macrocarpa* may be andromonoecious or androdioecious as well, but instead of the inflorescence of functionally female plants having many functionally female umbellules as in *C. triloba*, it is made up of a single umbellule (Figure 1F1). Furthermore, when male and bisexual flowers are present, the inflorescence will bear only a single functionally female umbellule (Figure 1F2). The male umbellules have three to five male flowers with glabrous petals. The hybrid is andromono-ecious (Figure 1E), but only a limited number of specimens is available. The inflorescence is otherwise compar- able to that of *C. macrocarpa* with villous male flowers (Figures 1F1, 1F2). In Table 3 the glabrous petals of *C. virgata*, *C. glauca* and the two *C. macrocarpa* populations are polarized as apomorphic, because of the presence of villous petals in the outgroup. *Centella virgata* is andromonoecious and *C. glauca* may be androdioecious or andromonoecious.

The morphological data analysis resulted in a partially resolved cladogram with a length of 11 steps and a consistency index of 0.90 (Figure 3A). The cladogram is not fully resolved as a polytomy occurs between the two *C. macrocarpa* populations and *C. glauca*.

Allozyme data

Genetic variation within species was observed at seven of the 15 enzyme-coding loci. The choice of five of these loci, i.e., CAP-1, GPI, PER, PGM-1 and PGM-2, for further data analysis was confirmed by their relatively high fixation index (F-statistic) values (Table 4, the values are explained in the caption). The alleles that contributed most to population differences at these loci are represented by characters 8 to 19 in Table 3 (their F_{ST} values are all

TABLE 4.—Summary of F-statistics at all loci. F_{IS} and F_{IT} are the fixation indices of individuals relative to the total population and its subpopulations, respectively. F_{ST} measures the amount of differentiation among subpopulations relative to the limiting amount under complete fixation

Locus	F_{IS}	F_{IT}	F_{ST}
AAT-1	0.188	0.364	0.217
ACP-2	1.000	1.000	0.429
CAP-1	0.201	0.781	0.726
GPI	0.850	0.944	0.630
PER	0.657	0.961	0.885
PGM-1	0.077	0.566	0.530
PGM-2	0.067	0.627	0.600
Mean	0.417	0.767	0.601

above 0.500). Figure 3B shows the dendrogram produced with DISPAN and the complete set of allozyme data whereas Figure 3C shows the dendrogram without the hybrid. Four cladograms were produced from the characters (8–19) in Table 3, of which the consensus tree is shown in Figure 3D. The length of the consensus tree is 23 steps with a consistency index of 0.73. When the hybrid was excluded from the data set, the resulting cladogram was fully resolved, with a length of 21 steps and a consistency index of 0.80 (Figure 3E). According to McDade (1995), a higher consistency value is to be expected, since the removal of a hybrid from the analysis should lead to a significant reduction in homoplasy.

Table 5 lists the genetic distances between the species and populations studied. From this information it is evident that the shortest genetic distance was found between the hybrid and the *C. macrocarpa* population from Kogel Bay. The genetic distance between the two *C. macrocarpa* populations is relatively small (0.091) when compared to the average distance between species (0.218). The species with the shortest genetic distance are *C. macrocarpa* and *C. triloba* (0.108) and the species with the longest distance between them are *C. macrocarpa* and *C. virgata* (0.350). The shortest genetic distances are those between *C. triloba*, the hybrid, and the two *C. macrocarpa* populations. This is what one would expect, given the proposed hybrid origin. *Centella glauca* and *C. virgata* are only linked into this group at a much greater genetic distance.

Table 5 lists results of the BIOSYS analysis used to establish the genetic diversity within populations. The genetic diversity within the *C. triloba* and the *C. macrocarpa* (Kogel Bay) populations is by far the greatest (mean heterozygosity per locus 14.2%, 15.4%; percentage of loci polymorphic 40, 40; mean number of alleles per locus 1.4, 1.13 respectively) while that of the *C. virgata* and the *C. macrocarpa* (Swartberg) populations is the smallest (mean heterozygosity per locus 4.9, 5.0; percentage of loci polymorphic 13.3, 13.3; mean number of alleles per locus 1.13, 1.13 respectively).

When the morphological and genetic data sets were combined, the result was a fully resolved cladogram with a length of 40 steps and a consistency index of 0.70 (Figure 3F). When the hybrid was removed from this data set, the tree length reduced to 32 steps and the consistency index improved to 0.87. This reduction in homoplasy is again consistent with our assumption of hybridization, following McDade (1995).

Geographical distribution of the putative hybrid and the parent species

Both *C. triloba* and *C. macrocarpa* occur in the Western Cape but *C. triloba* is limited to the Cape Peninsula and coastal areas of the Caledon District, whereas *C. macrocarpa* is more widespread in the region. The hybrid is very localized in occurrence. Only two plants were found at Kogel Bay and both parent species occur at the same locality (Figure 4). The *C. triloba* population occurs on a relatively flat area closer to the sea than the *C. macrocarpa* population, which grows on a steep scree slope. The putative hybrids occurred between the two populations at the foot of the scree slope.

DISCUSSION

Centella triloba, the hybrid and *C. virgata* formed morphologically discrete clades with only one overlapping morphological character between *C. virgata* and the hybrid, namely the presence of ribbed fruit. *Centella glauca* and *C. macrocarpa* are mainly distinguished by their habit differences and the distinctly glaucous leaves of the former species (Schubert & Van Wyk 1996). A polytomy results as these autapomorphic characters were not used in the cladogram (Figure 3A). The morphological data showed that the hybrid is intermediate between *C. triloba* and the rest of the study group. Characters, such as the presence of isobilateral leaves in the hybrid, group it with *C. macrocarpa*, whereas the similarities with *C. triloba* all appear to be symplesiomorphies. McDade (1990) also found that hybrids do not lead to unresolved cladograms with high levels of homoplasy, but that they emerge as

TABLE 5.—Genetic variation and differentiation within and between: *C. triloba* (P1); a putative hybrid between *C. triloba* and *C. macrocarpa* (H); *C. macrocarpa* (resprouter, population from Kogel Bay) (P2); and *C. macrocarpa* (reseeder, population from Swartberg Pass) (P3); *C. virgata* (V); and *C. glauca* (G)

Population	mean heterozygosity per locus	% of loci polymorphic	mean # of alleles per locus
P1	14.2%	40.0	1.4
H	6.7%	13.3	1.13
P2	4.9%	13.3	1.13
P3	8.1%	26.7	1.13
V	5.0%	13.3	1.13
G	15.4%	40.0	1.13

Nei's (1978) unbiased genetic distance between: *C. triloba* (P1); a putative hybrid between *C. triloba* and *C. macrocarpa* (H); *C. macrocarpa* (resprouter, population from Kogel Bay) (P2); and *C. macrocarpa* (reseeder, population from Swartberg Pass) (P3); *C. virgata* (V); and *C. glauca* (G)

Population	H	P2	P3	V	G
P1	0.139	0.108	0.297	0.151	0.208
H		0.005	0.124	0.311	0.156
P2			0.091	0.198	0.127
P3				0.350	0.254

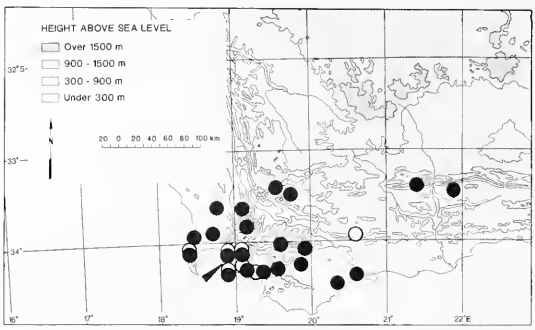

FIGURE 4.—The known geographical distribution of *C. triloba*, ○; *C.* hybrid (indicated by arrow); and *C. macrocarpa*, ●.

basal to the clade which includes the most derived of the two parents (Figure 3A, F).

In choosing *C. triloba* as outgroup, we expected the topology A in Figure 3. Obviously, the similarities between the hybrid and *C. macrocarpa* would be interpreted as synapomorphies. If we had chosen *C. virgata* or *C. glauca* as outgroup, the reverse would have been true, i.e. the hybrid would have grouped with *C. triloba*. According to McDade (1995), 'Hybrids may express the derived states (apomorphies) of both parents, the apomorphies of one parent, partially derived conditions that are intermediate between the parents, or states that are more extreme than either (autapomorphies)'. If our putative hybrid was unrelated to the two species with which it was found growing, we would not have expected any intermediate characters. The data in Table 3 show the following pattern of character expression: four characters shared with *C. triloba*, seven characters shared with *C. macrocarpa*, three intermediate characters and three unique characters. It thus seems reasonable to conclude that the relatively high number of intermediate characters support our assumption of hybrid origin based on field observation. Even if the two plants found at Kogel Bay eventually turned out to be a new species (we do not exclude this possibility) we are arguing that it is of hybrid origin, being derived from *C. triloba* and *C. macrocarpa*.

Allele frequencies calculated at CAP-1 (A, B and C alleles), PGM-1 (A and B alleles) and PGM-2 (B and C alleles) grouped the hybrid together with *C. macrocarpa*, whereas the allele frequencies recorded for PER (B and C alleles) coincided for the hybrid and *C. triloba*. The larger number of allele frequencies shared with *C. macrocarpa* resulted in the hybrid being nested in the polytomy in Figure 3D. This is again in agreement with the proposals of McDade (1995), who suggested that the hybrid would be placed near to the parent that has the most derived characters. The combined morphological and genetic data also present supporting evidence for the hypothesized hybrid origin. When the hybrid was omitted, a fully resolved topology resulted, with a substantial improvement in both the tree length and consistency index (Figure 3E). The morphology gives only a partially resolved cladogram (Figure 3A) but the *C. glauca*/*C. macrocarpa* polytomy becomes fully resolved in the combined analysis, with the genetic data responsible for the improvement. These analyses are consistent with two generalizations: 1, removal of the hybrid improves the resolution and 2, both data sets (morphological and genetic) contribute to resolving different parts of the topology, as is evident in Figure 3A & F. *C. virgata* is clearly separated from *C. macrocarpa* in all the analyses, which gives useful support for considering it as a distinct species despite the close similarity to some forms of *C. macrocarpa* (particularly the reseeding forms). Fire-survival appears to be a homoplasious character which has evolved convergently in different species.

The *C. macrocarpa* populations were grouped together on the final cladogram (Figure 3F). This is interesting since the Swartberg population is a reseeder and the Kogel Bay population is a resprouter, and the genetic distance between them (Table 5) was less (0.091) than between the *C. macrocarpa* reseeder population and another closely similar reseeder species, *C. virgata* (0.350). Likewise, the distance of 0.091 is less than the distance between the resprouting *C. glauca* and the resprouting population of *C. macrocarpa* (0.127). Thus the phenomena of reseeding and resprouting (Schutte *et al.* 1995) may occur in a single species.

There is a possible correlation in the genetic variation of the reseeder populations and also of the resprouter populations, i.e. that resprouters are genetically more variable than the reseeder populations. The latter are more prone to genetic bottlenecks, as was proposed by Schutte *et al.* (1995), because presumably only one generation is present at any given time, while the survival of the resprouters leads to a mixture of numerous generations within the same population. Further studies, including larger sample sizes, are needed to confirm the relationship between genetic variation and fire-survival strategy in *Centella*.

The demonstration that hybridization occurs between two species of *Centella* that are not sister taxa indicates that a strictly hierarchical infrageneric classification may be an unobtainable goal. Even the cladistic method may become problematic, particularly when nodes are weakly supported [see McDade (1992, 1995) for a detailed discussion of the impact of hybrids on cladistic analysis]. The assumption of divergent evolution needed for the cladistic method may thus not be an accurate reflection of the actual mechanisms of evolution within the genus. If evolution is indeed reticulate, then the identification of lineages of ancient hybrid origin becomes problematic (McDade 1990). Nevertheless, the use of different data sets in determining phylogenetic relationships between *Centella* species, resulted in a closer proximation to the true phylogeny than would have been possible with either of the data sets (Shakalee & Whitt 1981; McDade 1995).

The new insight into evolutionary relationships in *Centella* provides a possible explanation for the reticulate pattern of character expression in the genus. Adamson (1951) was unable to create mutually exclusive infrageneric taxa and coped with the problem by including some species in more than one series. Roux *et al.* (1978), Winter & Van Wyk (1995) and Allison (1995) have used cladistic methods to study Apiaceae, marking the beginning of a

rigorous, empirical approach to classification in this family. However, if a hybrid disrupts the pattern of character expression by inheriting the defining apomorphies of unrelated parents from different sections or series, then it will not be possible to use cladistics in the normal way because the method relies on divergence. McDade (1995) highlighted several new attempts at resolving this problem.

ACKNOWLEDGEMENTS

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Red Data List of southern African plants. 1. corrections and additions

C. HILTON-TAYLOR*

The recently published *Red Data List of southern African plants* (Hilton-Taylor 1996), by its very nature, is dynamic and constantly changing. It was therefore proposed that any corrections to the List, such as changes in names, conservation status and distributions; deletions; and new additions, should be published annually in *Bothalia* to provide users of the List with information as up-to-date as possible. These corrections and additions will form a series similar to the contributions to the *Flora of southern Africa* (*FSA*) published in *Bothalia* as '*FSA* contributions'.

It should be noted that all corrections and comments given here pertain only to the information published in the Red Data List (Hilton-Taylor 1996), whereas the additions are new records which must be added to the List. Readers are referred to Hilton-Taylor (1996) for an explanation of the methodology used and for definitions of all the terms. The old IUCN Red Data Categories have been used here again, rather than the new categories. A departure from the methodology described in Hilton-Taylor (1996) is the use of the new South African provinces. The abbreviations for the old provinces are, however, given in brackets so that information is comparable to that in the published List. Name changes for those taxa in the Red Data List whose conservation status is not threatened (nt), neither locally nor globally, are not given here. Changes in conservation status (hereafter referred to as status) apply to both the local and global level, unless otherwise specified. Corrections, additions or deletions of taxa in the Extinct, Endangered or Vulnerable categories should also be made in Appendix 2 where necessary.

CORRECTIONS

1. The status of *Amphithalea rostrata* A.L.Schutte & B.-E.van Wyk, should be changed from Rare (R) to Endangered (E) as it is only known from a small population near Pearly Beach on the Agulhas Plain.

2. The author citation for *Apodolirion lanceolatum* should be (Thunb.) Baker not (L.f.) Benth. (Hilliard & Burtt 1973).

3. A population of *Argyrolobium crinitum* (E.Mey.) Walp. (Edwards 1996) was recently rediscovered (J.H.J. Vlok pers. comm.). The conservation status of this attractive shrub should therefore be changed from Extinct (Ex) to Endangered (E). The population comprises only a dozen plants along a road verge and approximately 200 individuals in a remnant piece of Renosterveld vegetation between wheat fields.

4. *Argyrolobium* sp. nov. (*Drège s.n.*, BM) has been formally described by Edwards (1996) as *Argyrolobium angustissimum* (E.Mey.) T.J.Edwards. Its Extinct (Ex) status is unchanged.

5. *Brachystelma discoideum* R.A.Dyer was incorrectly listed as being globally Rare (R) and endemic to the *FSA* region. S. Venter (pers. comm.) reports that it also occurs in Botswana and Zimbabwe. Pending further details, its global status and status in Botswana should be changed to Insufficiently Known (K).

6. *Ceropegia filiformis* (Burch.) Schltr. is now known to occur on the Great Karas Mountains in southern Namibia where it is fairly common, and there have also been a number of new collections from the Northern and Eastern Cape (Bruyns 1995). The conservation status for this species should therefore be changed from Rare (R) locally (Cape) and globally to not threatened (nt) and a status of nt should be listed under Namibia (N). The Vulnerable (V) status under the Free State (O) remains unchanged as it is only known from a single collection made in that province (Bruyns 1995).

7. The status of *Coelidium obtusilobum* Granby, should be changed from Rare (R) to Endangered (E) as it is only known from the type collection made by Elsie Esterhuysen in 1954. As this area has been fairly well collected this species may even be Extinct (Ex).

8. *Coelidium vlokii* A.L.Schutte & B.-E.van Wyk, is threatened by agricultural activities and its status should be changed from Rare (R) to Endangered (E).

9. Nordal & Fangan (1994) have shown that *Crinum zeylanicum* (L.) L., pro parte, sensu Nordal (1977) should be regarded as a synonym of *Crinum ornatum* (L.f. ex Aiton) Bury. *Crinum kirkii* sensu Verdoorn in *Bothalia* 11: 38 (1973) non Baker, previously listed as a synonym of *C. zeylanicum* (L.) L., should therefore also be listed as a synonym of *C. ornatum*. The conservation status remains not threatened (nt) as it is a common widespread taxon.

10. *Cyclopia bowieana* Harv. is not as scarce as previously thought and its status should be changed from Indeterminate (I) to not threatened (nt).

11. *Cyclopia burtonii* Hofmeyr & E.Phillips (note the corrected spelling of Hofmeyr) is a scarce endemic from the upper slopes of the Great Swartberg Mountains. As it is susceptible to frequent burning, the conservation status should be changed from Indeterminate (I) to Rare (R).

12. Several attempts to relocate *Cyclopia filiformis* Kies, have been unsuccessful; the conservation status should therefore be changed from Insufficiently Known (K) to Extinct (Ex) (A.L. Schutte pers. comm.).

13. The status of *Cyclopia latifolia* DC. should be changed from Vulnerable (V) to Endangered (E) as it is known only from two sites, one comprising 23 plants and the other just a single individual (J.H. de Lange pers. comm.)

14. *Cyclopia pubescens* Eckl. & Zeyh. is severely threatened by expanding urbanisation and its status should be changed from Insufficiently Known (K) to Endangered (E).

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15. The conservation status of *Echiostachys spicatus* (Burm.f.) Levyns was incorrectly given as Vulnerable (V); this should be changed to Rare (R) (Hall & Veldhuis 1985).

16. The realisation that plants named as *Encephalartos lebomboensis* I.Verd. from the Lebombo Mountain range in KwaZulu-Natal and Swaziland were incorrectly identified and represent a separate and undescribed species (Vorster 1995, 1996e) means that the distribution and status of *E. lebomboensis* needs to be corrected. *E. lebomboensis* only occurs in the Pongola River valley of KwaZulu-Natal (KN) with a disjunct population on the Lebombo range in Mpumalanga (T) (Vorster 1996e). As a result of its reduced distribution range and population size, the conservation status of this species should be upgraded from Rare (R) to Vulnerable (V) in both provinces and globally. The conservation status given under Swaziland should be deleted.

17. The population of *E. lebomboensis* in the Pongola River valley has popularly been referred to as the 'Piet Retief' form (Vorster 1995) and hence the use of *Encephalartos* sp. nov. 'Piet Retiefii' (*Vorster 2977*, PRE) in the Red Data List (Hilton-Taylor 1996). Following the taxonomic changes described above, this 'name' must now be placed into synonymy under *E. lebomboensis* (Vorster 1995).

18. *Encephalartos* sp. nov. 'Msinga' (*Vorster 2949*, PRE) was formally described by Vorster (1996c) as *Encephalartos msinganus* Vorster. Its conservation status is still Endangered (E).

19. *Encephalartos* sp. nov. 'venitus' (*Steyn 318*, PRE) was recently described by Vorster (1996d) as *Encephalartos venetus* Vorster. Unbeknown to Vorster, a manuscript decribing this taxon as *Encephalartos nubimontanus* P.J.H.Hurter, was submitted almost simultaneously for publication elsewhere (Hurter 1995; Hurter & Claassen 1996). As *E. nubimontanus* was effectively and validly published before *E. venetus*, it is accepted as the correct name for the taxon while *E. venetus* is regarded as a synonym. The conservation status of this taxon remains Endangered (E).

20. E.G.H. Oliver (pers. comm.) has found that specimens previously named as *Erica parvulisepala* H.A.Baker, match the type of *Erica xanthina* Guthrie & Bolus, and as the latter is the older name it must take priority. *E. parvulisepala* will therefore be reduced to synonymy under *E. xanthina* (E.G.H. Oliver pers. comm.). As a result of this taxonomic change, the conservation status of *E. xanthina* must be changed from Insufficiently Known (K) to Rare (R).

21. A recent study of *Euphorbia barnardii* A.C.White, R.A.Dyer & B.Sloane (Knowles & Witkowsi 1996) has shown that it is not as threatened as previously thought and that its conservation status should be changed from Endangered (E) to Vulnerable (V).

22. The distribution of *Gladiolus appendiculatus* G.J.Lewis var. *appendiculatus* should be extended to KwaZulu-Natal (KN) where it is also Rare (R).

23. The spelling of the specific epithet for *Haemanthus pauculiflorus* Snijman & A.E.van Wyk should be corrected to *pauculifolius* (Snijman & Van Wyk 1993).

24. The spelling of the specific epithet for *Haworthia mcmurtryi* C.L.Scott should be changed to *macmurtryi* in accordance with ICBN Article 60C.4 (Greuter *et al.* 1994).

25. The conservation status of *Liparia angustifolia* (Eckl. & Zeyh.) A.L.Schutte should be changed from Insufficiently Known (K) to Endangered (E). This species occurs in marshy areas along the coast between the Cape Peninsula and Hermanus and many populations have been destroyed by coastal developments.

26. The status of *Liparia splendens* (Burm.f.) Bos & de Wit subsp. *splendens*, should be changed from Insufficiently Known (K) to Rare (R).

27. *Liparia laevigata* (L.) Thunb. is confined to the Cape Peninsula, occurring only in marshy places on Constantiaberg and Table Mountain; its status should be changed from Insufficiently Known (K) to Rare (R).

28. *Liparia myrtifolia* Thunb., is now known to have a wide distribution in the southwestern Cape occurring on many mountain ranges where it appears to be secure. Its conservation status should therefore be changed from Insufficiently Known (K) to not threatened (nt).

29. *Lobostemon* sp. nov. (*Buys 432*, STE) is now formally described as *Lobostemon belliformis* Buys (Buys & Van der Walt 1996). Its conservation status needs to be changed from Vulnerable (V) to Endangered (E), as only twenty plants are known to survive in the wild (Buys & van der Walt 1996).

30. *Podalyria burchellii* DC. is incorrectly recorded as occurring in KwaZulu-Natal. Its status remains unchanged.

31. *Podalyria cordata* (Thunb.) R.Br., although localised, is not as threatened as previously thought and its status should be changed from Vulnerable (V) to Rare (R).

32. Recent attempts to relocate *Podalyria microphylla* E.Mey. in its natural habitat, have been unsuccessful, and its status should therefore be changed from Indeterminate (I) to Extinct (Ex). Its habitat has largely been replaced by urbanisation.

33. The <D> which occurs after the author citation for *Podalyria velutina* Burch. ex Benth. is a typographical error which should be deleted.

34. The following entry should be inserted into Appendix 3: *Polycarena capitatum* Benth. *sensu* Hall *et al.* (1980) see Phyllopodium heterophyllum *(L.f.) Benth.*

35. The <D> which occurs after the author citation for *Pseudopentameris obtusifolia* (Hochst.) N.P.Barker, is a typographical error which should be deleted. The conservation status of this species should also be changed from Insufficiently Known (K) to Rare (R) (Barker 1995).

36. Investigation by P.V. Bruyns (pers. comm.) into the identity and distribution of *Senecio sarcoides* (DC.) C.Jeffrey, has shown that it is a far more common and widespread species in the Western and Northern Cape (C) than previously thought. Its conservation status should therefore be changed from Insufficiently Known (K) to not threatened (nt).

37. For *Sonderina streyi* Merxm., the status of Insufficiently Known (K) was omitted from under Namibia.

38. *Stirtonanthus taylorianus* (L.Bolus) B.-E.van Wyk & A.L.Schutte, is not as threatened as previously thought and its status should be changed from Vulnerable (V) to Rare (R). The spelling of the specific epithet of this taxon was incorrectly given as '*tayloriana*' in Appendix 2.

39. The following entry under Appendix 3 of the List, *Priestleya tomentosa* (L.) Druce see Liparia vestita *Thunb.*

is incorrect, and should be replaced with the following: *Priestleya tomentosa* sensu Hall & Veldhuis (1985) auct. non (L.) Druce see Xiphotheca fruticosa *(L.) A.L.Schutte & B.-E.van Wyk.* The entry for *L. vestita* should be deleted from Appendix 1 and a new entry for *X. fruticosa* should be added. This endemic Western Cape (C) taxon was previously thought to be Rare (R) but is now better classified as not threatened (nt) because its distribution has been greatly expanded.

40. *Xiphotheca canescens* (Thunb.) A.L.Schutte & B.-E.van Wyk, should be reclassified from Insufficiently Known (K) to Vulnerable (V) because of its very restricted distribution close to an expanding farming area.

41. *Xiphotheca elliptica* (DC.) A.L.Schutte & B.-E.van Wyk, previously listed as Indeterminate (I) should be reclassified as not threatened (nt) as it is a fairly common high altitude mountain species.

42. *Xiphotheca guthriei* (L.Bolus) A.L.Schutte & B.-E.van Wyk, is severely threatened by farming practices and its status should therefore be changed from Insufficiently Known (K) to Endangered (E).

43. The status of *Xiphotheca lanceolata* (E.Mey.) Eckl. & Zeyh., must be changed from Indeterminate (I) to Endangered (E) as it is severely threatened by urban expansion on the Cape Flats.

44. The status of *Xiphotheca reflexa* (Thunb.) A.L.Schutte & B.-E.van Wyk, must be changed from not threatened (nt) to Vulnerable (V) as it only occurs on the Western Cape (C) lowlands in areas now largely replaced with agricultural lands and urban areas. Recent searches for this species were unsuccessful (A.L. Schutte pers. comm.).

45. The status of *Xiphotheca tecta* (Thunb.) A.L.Schutte & B.-E.van Wyk, should be changed from Rare (R) to not threatened (nt) as it has a wide distribution and is relatively safe.

46. *Erica* sp. nov. '*flexistyla*' (*Oliver 10558* STE) has been formally described by Oliver & Oliver (1995) as *Erica flexistyla* E.G.H.Oliv. Its Endangered (E) status remains unchanged.

47. *Erythrophysa transvaalensis* I.Verd. is not endemic to the *FSA* region as it also occurs in southwestern Zimbabwe, it's rare (R) status remains unchanged.

48. The <D> which occurs after the author citation for *Nemesia micrantha* Hiern, is a typographical error which should be deleted.

49. The <D> which occurs after the author citation for *Nemesia picta* Schltr., is a typographical error which should be deleted.

50. Based on information from C.J. Geldenhuys (pers. comm.) the status of *Ocotea bullata* (Burch.) Baill. should be changed from a question mark (?) under Cape (C) to not threatened (nt), and therefore its global status should also be changed from Vulnerable (V) to not threatened (nt).

51. *Ocotea kenyensis* (Chiov.) Robyns, is not endemic to the *FSA* region and its global status should be changed from (R) to not threatened (nt).

52. The status of *Strelitzia alba* (L.f.) Skeels, should be changed from Indeterminate (I) in the Cape (C) and globally, to not threatened (nt), (C.J. Geldenhuys pers. comm.).

53. The global conservation status of *Strelitzia juncea* Link, should be Rare (R).

54. The global status of *Vlokia ater* S.A.Hammer, should be Rare (R).

ADDITIONS

All taxa listed here are endemic to the *FSA* region and the global conservation status is therefore the same as the local status (province and/or country) unless otherwise indicated. The status of newly recorded taxa not previously known to occur in the *FSA* region is not given here, unless the taxon concerned is already classified as threatened elsewhere. The conservation status of these taxa will be evaluated at a later stage once more collecting information is available. The additions are listed in alphabetical order by family and genus.

Aizoaceae

1. *Delosperma guthriei* Lavis, is a Vulnerable (V) species confined to coastal areas at Kleinmond and Hermanus in the Western Cape (C) where it is threatened by coastal development and alien plant invasions.

2. *Drosanthemum austricolum* L.Bolus, is an Endangered (E) limestone endemic from the Agulhas Plain, Western Cape (C) where it is confined to an area densely infested by alien species.

3. *Lampranthus stenus* (Haw.) N.E.Br., is a Rare (R) species recorded from lowland coastal sites from the Cape Peninsula to Hermanus, Western Cape (C).

Apiaceae

1. *Centella ternata* M.T.R.Schubert & B.-E.van Wyk, is an Insufficiently Known (K) species known only from the type collection made by Elsie Esterhuysen in the Cederberg, Western Cape (C) in 1962 (Schubert & Van Wyk 1995).

2. *Centella umbellata* M.T.R.Schubert & B.-E.van Wyk, is an Insufficiently Known (K) species known only from the type collection made by Elsie Esterhuysen on the mountain slopes above Porterville in the Western Cape (C) in 1979 (Schubert & Van Wyk 1995).

Asteraceae

1. *Hoplophyllum ferox* Sond., is a very poorly known species collected from only two localities in the Western Cape (C) portion of the Great Karoo last century. Until further information is obtained, its conservation status is Indeterminate (I).

2. *Metalasia octoflora* DC., is a Vulnerable (V) species confined to Renosterveld fragments on the lowlands along the west coast of the Western Cape (C).

Euphorbiaceae

Euphorbia versicolores G.Will., is a Rare (R) species known only from two small colonies in the central Richtersveld of the Northern Cape (C). Although only approximately 20 plants in total are known, this species is not classified as Endangered or Vulnerable at this stage, as it is not considered to be severely threatened at present. There are probably other undiscovered populations in this botanically poorly explored remote, mountainous area (Williamson 1995).

Fabaceae

A large number of species in this family have been added to the Red Data List as a result of a recent detailed systematic study of the tribes Podalyrieae and Liparieae (Schutte 1995a):

1. *Amphithalea alba* Granby, is a Vulnerable (V) limestone endemic from the Agulhas Plain, Western Cape (C).

2. *Amphithalea axillaris* Granby, is a Rare (R) species from the Langeberg and Outeniqua Mountains, Western Cape (C).

3. *Amphithalea biovulata* (Bolus) Granby, is a Vulnerable (V) species recorded mainly from the Agulhas Plain, Western Cape (C). It is threatened by agricultural activities.

4. *Amphithalea ericifolia* (L.) Eckl. & Zeyh. subsp. *erecta* Granby, is an Endangered (E) taxon from the west coast lowlands, Western Cape (C).

5. *Amphithalea ericifolia* (L.) Eckl. & Zeyh. subsp. *scoparia* Granby, is a Rare (R) taxon from the Hottentots Holland and Riviersonderend Mountains, Western Cape (C).

6. *Amphithalea ericifolia* (L.) Eckl. & Zeyh. subsp. *minima* Granby, is a Rare (R) highly localised endemic taxon from the Riviersonderend Mountains, Western Cape (C).

7. *Amphithalea imbricata* (L.) Druce, is a Rare (R) species from the Cape Peninsula and Hottentots Holland Mountains in the Western Cape (C).

8. *Amphithalea oppositifolia* L.Bolus, is an Endangered (E) species from the Kogelberg and Betty's Bay area, Western Cape (C).

9. *Amphithalea sericea* Schltr., is a Vulnerable (V) species from the Agulhas Plain, Western Cape (C).

10. *Amphithalea speciosa* Schltr., is an Endangered (E) species from the Elim area near Bredasdorp, Western Cape (C), where it is threatened by agricultural activities.

11. *Amphithalea stokoei* L.Bolus, is an Endangered (E) species known only from a single locality on the Hottentots Holland Mountains, Western Cape (C).

12. *Ampithalea tomentosa* (Thunb.) Granby, is a Vulnerable (V) species occurring on the coastal lowlands between Betty's Bay and Riversdale, Western Cape (C), where it is threatened by coastal development and agricultural activities.

13. *Amphithalea virgata* Eckl. & Zeyh., occurs only in the Caledon area of the Western Cape (C), where it is highly Endangered (E) by agricultural activities.

14. *Coelidium bowiei* Benth., is a Vulnerable (V) highly localised species from the Houhoek, Caledon and Kleinmond areas, Western Cape (C).

15. *Coelidium flavum* Granby, is a poorly known but apparently Rare (R) species confined to a small area on the Outeniqua Mountains, Western Cape (C).

16. *Coelidium minimum* Granby, is a Rare (R) species known only from the type collection made near Niewoudtville, Northern Cape (C). This area has been relatively well collected and it is surprising that no further collections have been made.

17. *Coelidium pageae* L.Bolus, is a Rare (R) species confined to the Montagu area, Western Cape (C).

18. *Coelidium purpureum* Granby, is a Rare (R) species known only from the type collection made in the Koue Bokkeveld Mountains, Western Cape (C).

19. *Coelidium spinosum* Harv., is a Rare (R) species recorded only from the Hex River Valley and Touwsrivier area, Western Cape (C).

20. *Cyclopia laxiflora* Benth., is known only from a few old records collected in the Knysna–Plettenberg Bay area, Western Cape (C). Despite numerous searches for this species, no traces of it have been found; it is therefore presumed to be Extinct (Ex).

21. *Liparia bonaespei* A.L.Schutte, is a poorly known Rare (R) species from the Hottentots Holland Mountains, Western Cape (C), where it has only been collected a few times (Schutte 1995b).

22. *Liparia calycina* (L.Bolus) A.L.Schutte, is a Rare (R) species confined to a few localities on the Hottentots Holland and Klein River Mountains, Western Cape (C).

23. *Liparia congesta* A.L.Schutte, is a Rare (R) species known only from a few localities in the Cederberg, Western Cape (C) (Schutte 1995b). Only one plant could be found during a recent search for this species and it is probably susceptible to frequent burning (A.L. Schutte pers. comm.).

24. *Liparia genistoides* (Lam.) A.L.Schutte, is a very Rare (R) species known only from two disjunct localities on the Kamanassie and Kouga Mountains in the Eastern Cape (C).

25. *Liparia graminifolia* L., has not been collected since 1829, when it was found by Ecklon near Simon's Town on the Cape Peninsula, Western Cape (C). This species probably became Extinct (Ex) as a result of urban development.

26. *Liparia parva* Vogel ex Walp., is a Rare (R) species confined to the Cape Peninsula, Western Cape (C).

27. *Liparia rafnioides* A.L.Schutte, is a Rare (R) species known only from a single locality in the Kogelberg Mountains, Western Cape (C) (Schutte 1995b).

28. *Liparia striata* A.L.Schutte, is confined to two hills near Swellendam–Heidelberg, Western Cape (C), where it is seriously Endangered (E) by farming activities (Schutte 1995b).

29. *Podalyria argentea* (Salisb.) Salisb., is a Rare (R) species restricted to the Cape Peninsula, Cape Flats and Hottentots Holland Mountains, Western Cape (C). Many of the populations on the lower slopes and flats have been destroyed by urbanisation (A.L. Schutte pers. comm.).

30. *Podalyria lanceolata* (E.Mey.) Benth., is a Rare (R) Langeberg endemic, Western Cape (C).

31. *Podalyria orbicularis* (E.Mey.) Eckl. & Zeyh., is a Rare (R) species known only from the Swartberg near Caledon and Genadendal Mountain, Western Cape (C).

32. *Podalyria pearsonii* E.Phillips, is a Rare (R) species recorded only from a few sites on the Bokkeveld escarpment near Niewoudtville in the Northern Cape and the Gifberg in the Western Cape (C).

33. *Podalyria reticulata* Harv., is a Rare (R) species known only from three old collections made on the Swartberg near Caledon, Western Cape (C). This taxon is doubtfully distinct from *P. orbicularis* (see above).

34. *Podalyria sericea* (Andrews) R.Br., is a Vulnerable (V) species confined to granite hills on the Cape Peninsula

and Cape Flats, Western Cape (C), where it is threatened by urbanisation.

35. *Stirtonanthus chrysanthus* (Adamson) B.-E.van Wyk & A.L.Schutte, is a highly localised Rare (R) endemic of the Klein Swartberg Mountains, Western Cape (C).

36. *Stirtonanthus insignis* (Compton) B.-E.van Wyk & A.L.Schutte, is a Vulnerable (V) species, limited to the mountains around Montagu. Some populations are threatened by farming activities.

37. *Xiphotheca cordifolia* A.L.Schutte & B.-E.van Wyk, is a Rare (R) species known only from a few collections made in the Hex River Mountains, Western Cape (C).

Iridaceae

1. *Galaxia parva* Goldblatt, is a Vulnerable (V) species confined to a single locality on the Agulhas Plain near Bredasdorp, Western Cape (C) (Goldblatt 1984).

2. *Gladiolus abbreviatus* Andrews, is a Vulnerable (V) species from the Western Cape (C). It was once fairly widespread but is now limited to remnant Renosterveld patches and road verges (J.C. Manning pers. comm.).

3. *Moraea regalis* Goldblatt & J.C.Manning, is a Rare (R) species known only from a single locality at De Rust in the Little Karoo, Western Cape (C) (Goldblatt & Manning 1995).

Poaceae

Pseudopentameris brachyphylla (Stapf) Conert, is a Rare (R) species from the Betty's Bay area of the Western Cape (C), which although not presently under threat, is 'potentially threatened' because of its narrow habitat requirements (Barker 1995).

Orchidaceae

Following a systematic revision of *Disa draconis* (L.f.) Sw. by Johnson & Linder (1995), this Western Cape (C) species needs to be added to the Red Data List as Endangered (E). One small population is protected at Rondevlei, a pocket-sized nature reserve, while the remainder are all under severe threat from urban and agricultural development (Johnson & Linder 1995).

Zamiaceae

1. *Encephalartos hirsutus* P.J.H. Hurter, is a Vulnerable (V) species known only from three small, widely separated populations in the Northern Province (T) (Hurter & Glen 1996).

2. *Encephalartos aplanatus* Vorster, is a critically Endangered (E) species which occurs in Swaziland (S); only a single population is known, comprising just a few scattered individuals (Vorster 1996a).

3. *Encephalartos brevifoliolatus* Vorster, is an Endangered (E) species known only from five individuals widely scattered over a few square kilometers in the Northern Province (T) (Vorster 1996b).

4. *Encephalartos senticosus* Vorster, is a Rare (R) species occurring along the Lebombo Mountain range in northern KwaZulu-Natal (KN) and Swaziland (S) (Vorster 1996e). This species is not endemic to the *FSA* region, as it also occurs in southern Mozambique where it is considered to be Vulnerable (V) (Bandeira *et al.* 1996). Large numbers of this species have been removed from the wild for horticultural purposes in the last 50 years (Vorster 1996e) and if this trend continues, its status will have to be changed to Vulnerable (V).

SUMMARY

As a result of the changes in status and the additions to the Red Data List given above, the statistics on the number of taxa in each threatened category need to be changed [see Table 2 of the Red Data List, Hilton-Taylor (1996)]. Sixty taxa are now presumed to be Extinct (Ex), 270 are Endangered (E), 432 Vulnerable (V), 1436 Rare (R), 375 Indeterminate (I) and 905 Insufficiently Known (K). The numbers in all the categories, except for the last two, have increased. Twelve taxa were removed from the List and 55 were added, giving a new total of 3 478 globally threatened taxa in the *FSA* region.

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Book Reviews

DYNAMICS OF WEED POPULATIONS by R.D. Cousens & M. Mortimer. 1995. *Cambridge University Press*, The Edinburgh Bldg, Shaftsbury Rd, Cambridge CB2 2RU, UK. Pp. 332. Hard cover: ISBN 0 521 49649 7, price £50.00, US$79.95. Soft cover: ISBN 0 521 49969 0, price £17.95, US$29.95.

The study of weed dynamics in agricultural situations has for centuries been largely directed at solving problems (how can the weeds be killed?). Large-scale problems associated with the invasive spread of alien plants into natural ecosystems is a much more recent phenomenon, and agricultural weed scientists have paid little attention to the study of the dynamics of such invasions. The study of invasions of natural systems has been the domain of ecologists who see the phenomenon as a special case of succession with considerable potential for shedding light on the forces that structure communities. With a few exceptions, studies of such invasions have paid little attention to advances in 'classical' weed science. Recent synthesis volumes in these disciplines have further contributed to the widening chasm. The authors of this timely volume set out to integrate recent advances from the two related fields. They believe there is a need to 'establish a framework of interlocking components, which together help us to predict and to manage the size of populations'.

In attempting this ambitious task, Cousens & Mortimer explore the dynamics of geographic range expansion (at various scales); dispersal within and between populations; processes involved in the regulation of population density; the intrinsic and extrinsic dynamics of population density; and the spatial dynamics of weed populations. The penultimate chapter is devoted to the evolution of herbicide resistance. I particularly enjoyed the section on the dynamics of geographic range expansion. Here, the authors point out the very real problem of recognizing phases in the invasion process which bedevil attempts at generalization and prediction. Extensive coverage is given to the well-studied invasion of large parts of North America by *Bromus tectorum*. They re-analyze data on the spread of this grass species to show how difficult it is to distinguish exponential increase from a two-phase increase incorporating a lag phase. Another chapter I found very useful was the one on mathematical models of population density. I can think of no better introduction on the topic.

The case studies are fairly heavily based in favour of Australian, UK and, to a lesser extent, North American examples. Herbaceous plants are also given much better coverage than woody plants. Despite this, the examples that are chosen cover a very wide range of situations, and everyone with an interest in weeds will find points that relate to their particular interest. As a plant ecologist working mainly on the ecology of woody plants invading natural vegetation, I certainly found a great deal of interest in this book. I unreservedly recommend it to all plant population ecologists and other researchers with an interest in manipulating plant populations. The volume would also be ideal as the foundation for a post-graduate course on the subject.

The book is a pleasure to read; it is very well written, the concepts are clearly developed, and there is a good balance between text, figures and tables. I found no typographical errors.

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THE ANTHER: FORM, FUNCTION AND PHYLOGENY, edited by W.G. D'Arcy and R.C. Keating. 1996. *Cambridge University Press*, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, UK. Pp. xii + 351, 267 illustrations (line drawings, cladograms and photomicrographs), 13 tables. Size: 253 × 193 mm. ISBN 0 521 48063 9. Price: hard cover, £55.00, US$80.00.

A comprehensive work on the male reproductive structures of flowering plants has for many years been overdue. This book with its focus on the anther as the fundamental unit of the male floral organ, provides an authoritative summation of the present state of knowledge and theories, scattered in botanical literature, about the stamen of extinct and extant angiosperms. Essentially, the book is derived from papers read at the 1993 International Botanical Congress in Yokohama, Japan, but additional chapters have been added to include, *inter alia*, a bibliography (Chapter 13) which lists 1 347 references, indexed by subject and plant family, relating to stamen morphology and anatomy.

Although the first chapter is basically intended to outline the contents of the book and to act as a primer for understanding the terms and concepts used to describe stamen structure and function, a formidable amount of detailed information is presented concisely, but in an easily readable style. Summaries of classical and current theories on stamen design, arrangement, structure, function and evolution are interwoven with data on morphological and anatomical characters and are related to modes of pollen delivery and pollinator behavioural patterns. Importantly, the introductory chapter stresses the necessity of solid primary observations, both in the field and the laboratory, for the collection of new information and the alignment and testing of facts and theories about stamens.

Keating's overview (Chapter 12) of the literature dealing with diverse techniques for studying the anther is a valuable contribution to the volume. Initially, methods for preparing specimens intended for serial sectioning and light and electron microscopical studies are discussed and the advantages of hand sectioning, various wet mount techniques, smears and clearing agents are pointed out. Numerous recently developed methods to elucidate the biochemical and genetic basis behind the known structural complexity in developing and in mature anthers are referred to and the well-chosen references contribute more valuable information. This review of methodology could, in combination with D'Arcy's outline, serve as an excellent textbook on the angiosperm stamen for biologists at the non-specialist level.

For specialists in the subdisciplinary fields of palaeobotany, taxonomy, comparative morphology, anatomy and embryology, this beautifully illustrated book offers much useful and interesting information and answers to questions which otherwise would require searching through many reference works. The mystery of the origin(s) of flowering plants is explored by using the results of cladistic analyses (Chapter 3) or evidence from the fossil record (Chapter 2). Since the stamen has been recognized as a model organ for addressing basic and applied problems concerning plant cell biology, morphogenesis, breeding and evolution, fundamental questions such as: 'Are stamens and carpels homologous?' are considered and critically evaluated from divergent perspectives. Anatomists and embryologists who are not particularly inclined towards phylogenetic studies, will appreciate contributions dealing with heterochrony, resorption tissue (the calcium oxalate package) and the diversity of endothecium patterns in anthers, while pollination ecologists will welcome Peter Bernardt's review on the role of the anther in zoophily.

The volume is elegant in style, has a good standard of finish and the format makes it a delight to handle. Errors in the text and references are few and insignificant. The illustrations are superb, informative and not a recycling of old ones, seen many times before. Literature cited in each chapter is listed separately by contributors and shows that the book is up to date: of the nearly 1 300 references included in Chapters 1–12 and ranging from 22–226 per chapter, 40% were published later than 1985, while less than 30% are older than 1970.

In conclusion, I must stress that the title of the book is extremely misleading. Although this is the first-ever authoritative work on angiosperm stamens, it is also a comprehensive source of references on floral biology and will, in time, become indispensible to both students and professional biologists. The price easily puts it in the realm of constitutional purchasing and the book should be available in all botanical li-

braries to stimulate and enhance research in numerous fields of basic and applied biology.

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TERRESTRIAL ORCHIDS: FROM SEED TO MYCOTROPHIC PLANT, by HANNE N. RASMUSSEN. 1995. *Cambridge University Press*, The Pitt Building, Trumpington St., Cambridge CB2 1RP, England. Pp. 444. ISBN: 0 521 45165 5. Price: hard cover: £45.00, US$64.95.

There is an imbalance in our general interest in orchids, as epiphytic species are preferred to terrestrial ones by most people, botanists as well as amateurs. Probably the main reason is that (unlike most terrestrial orchids) epiphytic species have frequently showy flowers and are fairly easy to cultivate. Epiphytic orchids are also the larger group, and it is estimated that approximately 70% of orchid species grow as epiphytes. Consequently, we know a great deal more about the biology of the epiphytic orchids than about that of the terrestrial species.

Nevertheless, the biology of terrestrial orchids has, for a variety of reasons, fascinated some botanists and plant lovers for centuries, but several aspects of it are still poorly understood. Many terrestrial species are rather rare and unpredictable in their appearance which is largely due to their heavy dependency on the associated mycorrhiza—sometimes thriving underground for several years and then suddenly emerging from the soil with a flowering shoot—and this sporadic nature enhances their appeal to the botanically interested community. The life cycle of terrestrial orchids has been something of a mystery for centuries because of their underground stage which is difficult to study. Especially, the germination of the minute seeds is still incompletely known. Due to their mycotrophy the cultivation of terrestrial species is difficult for the most part, but as a consequence, maintaining them in culture has become a new challenge for the advanced grower. Especially at a time when many terrestrial orchids are becoming increasingly rare and their conservation is rapidly becoming a high priority, a better understanding of their germination and growth requirements is vital.

In view of our incomplete knowledge Hanne Rasmussen's comprehensive book on the life cycle and the fungal associations of terrestrial orchids is a most welcome addition to the orchid literature. This book is the first that deals extensively with the aspect of the biology of the terrestrial orchids since the work of Burgeff in the first half of the century (Burgeff 1911, 1936, 1954). The present book deals with the holarctic species only. The first few chapters explain the properties of their dust-like seeds, the germination requirements, germination processes, associated mycorrhizal fungi, as well as the development of the seedling to the mature plant. Ecological and evolutionary consequences of the orchid-mycorrhiza symbiosis are also outlined. A chapter on substrates and the propagation with relation to mycorrhizal fungi describes our present state of knowledge in this field, and will be particularly useful for orchid growers. The life cycle of the holarctic species of 36 genera of terrestrial orchids is discussed in detail in a subsequent chapter. The genera are mostly European, but a few North American and Asian genera have also been included. Throughout the text the available literature on these aspects is reviewed, and is supplemented by personal observations which the author has made in the field as well as in laboratories, both in Maryland, USA, and in Copenhagen, Denmark. Obviously several aspects are still insufficiently understood, and such gaps in our knowledge are pointed out by the author, and it is hoped that future students will be able to solve some of these problems. Appendix A lists the nutrient substrates mentioned in the text, and Appendix B is a list of scientific names and synonyms. An extensive list of references and an index conclude the book.

The text is clearly and concisely written, and is illustrated by black and white line drawings and photographs. There are very few errors, like genus *Hammerbya* instead of *Hammarbya* (p. 135) or *Cypripedium calceolus* var. *parviflorus* and var. *parviflora* instead of var. *parviflorum* (p. 241). Considering the abundance of terrestrial orchids in southern Africa, the general chapters of this book are certainly relevant to our region although it has not been established yet if, and how far, the data obtained in orchids from the northern hemisphere can also be applied to southern hemisphere species. Australian and South African terrestrial orchids are occasionally mentioned in the text, but a slight limitation of the new book to us south of the equator is its geographical range. The publication—particularly the description of the life cycle of various genera—will certainly be of greater interest to readers in the northern hemisphere or at least to those with a strong interest in orchids from that hemisphere.

On the whole this new book can be widely recommended, both for botanists and horticulturalists. Being invaluable for our understanding of the biology of the terrestrial orchids, it will also appeal to conservationists who will find, e.g. information on species suitable for re-introduction, or information on germination and growth requirements of certain rare species.

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Busani, M.A. Driver
Dlungwane, R. General Foreman
Gabuza, A. Groundsman I
Gates, Ms J.E. N.D.(Parks & Recreation Admin.), N.D. (Hort.) Intermed.D.(Marketing Management). Principal Horticulturist. *Kniphofia*, forest spp.
Hlela, C. Groundsman I
Mbanjwa, Z. Groundsman I
Mbense, A. Groundsman I. Machine operator
Mdluli, K. Groundsman I
Mncwabe, Ms A. Groundswoman I
Mncwabe, P. Groundsman I
Mpangase, A. Groundsman I
Mpulo, D.H. Groundsman I
Mthalane, A. Groundsman I
Mtolo, C. Groundsman II. Team leader
Nkabini, A. Groundsman I
Nzakwe, W. Groundsman I
Radebe, A. Groundsman I
Sokhela, P. Groundsman I
Van der Merwe, Ms M.E.H. Senior Administration Clerk
Zimu, J. Groundsman I
Zimu, S. Groundsman I
Zondi, A. Groundsman I
Zondo, Z. Groundsman I
Zuma, J. Groundsman I
Zuma, Ms K. Groundswoman I

FREE STATE NBG—BLOEMFONTEIN

Britz, R.M. N.D.(Forestry). Chief Research Technician

Dweba, K.P. Groundsman I. Entrance
Eysele, Mrs J.P. Senior Administration Clerk
Lekhetho, M.J. Groundsman II. Maintenance
Lekhetho, T.S. Groundsman I. Nursery
Lumley, M.J. Principal Research Technician. Nursery
Mabula, S.K. Groundsman I. Maintenance
Masheane, M.D. Tractor driver
Mbolekwa, G.M. Groundsman II. Nursery
Mbolekwa, L.M. Groundsman II. *Rhus*, display
Mohokare, L.J. Groundsman II. Maintenance
Moima, T.J. Groundsman I. Braai area, maintenance
Mopeli, M.J. Groundsman I. Bulb area
Moticoe, Mrs M.A. Groundswoman I. Nursery
Motse, V.D. Groundsman I. General garden
Mpeli, P.A. Groundsman I. Nursery
Nakanyane, R.B. General Foreman
Nakedi, N.J. Driver
Nonjinge, S.H.B. Principal Research Technician
Olifant, D.M. Groundsman I. Kiosk area
Radithlare, Mrs E.M. Groundswoman I. Offices & nursery
Sebolai, Mrs C.L. Groundswoman I. Seed room nursery
Sebolai, P.R.A.N. Groundsman II. Tools maintenance
Semenyane, T.D. Groundsman I. Maintenance
Thaele, Mrs M.E. Food services Aid I

PRETORIA NBG

Heilgendorff, J.P. H.N.D.(Hort.). Chief Research Technician

Baloyi, F.R. Groundsman I
Baloyi, J.K. Groundsman I
Baloyi, S.J. Driver/Operator
Baloyi, S.M. Dip.(IBM) Specialized Auxiliary Services Officer
Chipi, S. Security Assistant
Chuma, S.J. Security Assistant
Dry, D.H. N.D.(Hort.). Chief Research Technician. Plant sales, records and gate control. Technical papers on horticulture and plants

Kemp, J. Groundsman I
Keyter, B.A. Senior Security Officer
Klapwijk, N.A. N.D.(Hort.), N.D.(Plant Prod.), N.D.(Diesel Fitting). Chief Research Technician. Planning and development. Index Nursery, New Plant Company
Kutama, B.T. Groundsman I
Letsoalo, H.M. Groundsman I
Mabasa, J.R. Security Assistant
Machika, S.M. Groundsman I
Mahlangu, J.J. Groundsman I
Makafula, W.P. Groundsman I
Makena, J.T. Groundsman I
Makena, S.M. Driver/Operator
Makena, S.N. General Foreman
Makgopo, C.K. Groundsman I
Makhafola, L.W. Groundsman I
Makhubela, D. General Foreman
Makhubela, P.K. Groundsman I
Makoeng, P.T. Groundsman I
Makola, J.M. Groundsman I
Makola, L.M. Groundsman II. Tractor driver
Makua, E.G. Groundsman I
Malewa, D.K. Groundsman I
Malobola, L.J. Groundsman I
Malobola, M. Groundsman II
Maluleke, J.M. Security
Mametja, A.M. Groundsman I
Mariri, J.N. Factotum
Marule, P.M. Groundsman II. Tractor driver
Masango, M.G. General Foreman
Mathabathe, D.S. Groundsman I
Matlala, S.M. Groundsman I
Matshika, S.P. Groundsman I
Mmakujwana, J.K. Groundsman I
Mnyangeni, L.D. Groundsman I
Modisha, D.M. Groundsman I
Mogoru, F.M. Groundsman I
Mogoru, S.C. Groundsman I
Mohale, F.R. General Foreman
Mohale, J.N. Groundsman I
Mokawe, R.N. Groundsman I
Molefe, J.R. Groundsman II
Molokomme, F.K. Groundsman I
Molomo, S.E. Groundsman I
Mononyane, J.B. Groundsman I
Motshweni, V.V. Groundsman I
Mudau, R.T. Groundsman I
Muhali, B.M. Groundsman I
Ngobeni, R.T. Groundsman I
Nkoana, J.M. Groundsman I
Nkwana, F.N. Driver/Operator
Noko, J.M. Research Assistant
Noku, A.Y. Groundsman II. Tractor driver
Ramakgaphola, A.M. Groundsman I
Ramatsetse, P.M. Security Assistant
Rampopana, A.M. Groundsman I
Schnackenberg, Ms H. Senior Provisioning Administration Clerk
Sete, L.B. General Foreman
Shilubane, E. Storeman Assistant
Shirindi, J.R. Groundsman I
Shirindi, S.M. Groundsman I
Sithole, J.D. Groundsman I
Strydom, D.J.F. N.T.C.III(Hort.), N.D.(Parks & Rec. Management). Chief Research Technician. Maintenance cycads
Swartz, Ms P. M.Sc. Senior Horticulturist. Scientific and horticultural curation of living collections; garden development; seedbank of endangered plants and succulents; Madagascan plants
Tefu, P.R. Groundsman I
Tloubatla, J.L. Groundsman I
Tolo, P.K. Groundsman I

WITWATERSRAND NBG—WILROPARK

Chaplin, P.J. N.T.C.Dip.(Hort.). Chief Research Technician

Hankey, A.J. N.D.(Hort.). Senior Research Technician
Head, Mrs S.E. Senior Administration Clerk
Khedzi, K.P. Groundsman I. Nursery
Lukhwa, N.A. Groundsman I. Garden
Luvhimbi, T.S. Groundsman I. Garden
Majamane, Z.E. Groundsman I. Garden
Mamosebo, M.A. Groundsman I. Garden
Manjati, Mrs N.L. Groundswoman II. Clerical Assistant
Manyikana, T.M. Groundsman I. Garden
Matsea, M.W. Groundsman I. Garden
Mbulaheni, N.P. Groundsman I. Garden
Mulibana, N.S. Groundsman I. Machine operator
Mmola, Ms B.E. Groundswoman I. Cleaner
Moteka, N.D. Outreach Education Officer
Ndou, A.P. Groundsman I. Garden
Ndou, M.W. Groundsman I. Machine operator
Ndwambi, N.W. Groundsman I. Garden
Ndzondo, Ms G.P. Groundswoman I. Cleaner
Nedambale, M.P. Groundsman II. Nursery
Nemalili, M.E. Driver
Nemalili, A.S. Groundsman II. Driver
Nekhavhambe, S.P. Groundsman I. Garden
Nenungwi, M.S. Groundsman I. Nursery
Rammela, N.N. Groundsman I. Machine operator
Randima, M. Groundsman I. Garden
Raphalalani, V.S. Groundsman I. Nursery
Steel, Miss B.S. N.D.(Nature Conservation), N.D.(Parks & Recreation Admin.), Dip.(Journalism). Senior Research Technician. Nursery, succulent and herb gardens, plant records
Tebeile, Ms Z.M. Groundswoman II. Clerical Assistant
Thupe, G.G. Groundsman I
Tshisikule, G.M. Groundsman I. Garden
Turner, MS S.L. B.Sc.(Hons.). Horticulturist
Van der Westhuizen, Mrs S. M.Sc. Environmental Educationalist
Vlok, Mrs S. Administration Assistant

RESEARCH DIRECTORATE

PRETORIA

Smith, G.F. Ph.D., F.L.S. Director: Research
Wolfson, Mrs M.M. Ph.D. Deputy Director

Smit, Mrs A.C. Personal Secretary
Steyn, Mrs E.M.A. Ph.D. Principal Scientist. Embryology

PLANT SYSTEMATICS SUBDIRECTORATE

PRETORIA

Smith, G.F. Ph.D., F.L.S. Systematics of succulents and rosulate, petaloid monocots

Arnold, T.H. Head: Data Management (Pretoria)
Koekemoer, Miss M. Curator: National Herbarium (Pretoria
Rourke, Dr J.P. Curator: Compton Herbarium (Cape Town)
Williams, Ms R. Curator: Natal Herbarium (Durban)

COMPTON HERBARIUM—CAPE TOWN

Rourke, J.P. Ph.D., F.L.S., F.R.S.S.Af. Assistant Director. Systematics of southern African Proteaceae, Stilbaceae

Beyers, Mrs J.B.P. M.Sc. Scientist. Assistant Curator: Collections. Taxonomy of the Gnidieae (Thymelaeaceae)
Cupido, Mrs C.S. Specialized Auxiliary Services Officer
Davidse, Mrs. E. Specialized Auxiliary Services Officer
Fellingham, Mrs A.C. B.Sc. Scientific Officer. Taxonomy of *Cliffortia* (Rosaceae)
Foster, Mrs S.E. Principal Typist
Kurzweil, H. Ph.D. Scientist. Systematics of southern African terrestrial orchids
Leith, Mrs J. Senior Administration Clerk
Manning, J.C. Ph.D. Specialist Scientist. Systematics of Iridaceae and Orchidaceae; anatomy
Oliver, E.G.H. M.Sc. Principal Scientist. Taxonomy of the Ericoideae (Ericaceae)
Paterson-Jones, Mrs D.A. (née Snijman) Ph.D. Principal Scientist. Systematics of Amaryllidaceae; cladistics
Roux, J.P. N.T.C.(Hort.), F.L.S., M.Sc. Principal Scientist. Systematics of Pteridophyta
Steiner, K.E. Ph.D. Specialist Scientist. Systematics of Scrophulariaceae and evolutionary interactions between oil-secreting flowers and oil-collecting bees

NATAL HERBARIUM—DURBAN

Williams, Ms R. B.Sc.(Hons.), H.D.E. Chief Scientific Officer.

Crouch, N.R. Ph.D. Scientist. Ethnobotanist
Mbonambi, B.M. Groundsman II. Gardener
Ngwenya, A.M. Principal Specialized Auxiliary Services Officer. Herbarium Assistant. Plant identification, plant information
Noble, Mrs H-E. Senior Administration Clerk
Nzimande, S.B. Groundsman II. Caretaker
Sikhakhane, T.B. Senior Specialized Auxiliary Services Officer. Herbarium Assistant. Plant identifications, herbarium services
Singh, Ms Y. B.Sc.(Hons.), H.E.D. Senior Scientific Officer. Taxonomy of *Zantedeschia*, plant identifications

NATIONAL HERBARIUM—PRETORIA

Koekemoer, Miss M. M.Sc. Assistant Director. Herbarium management. Taxonomy of Poaceae, Asteraceae: *Disparago*, *Stoebe*, *Amphiglossa*, *Elytropappus*, *Pterothrix* and *Bryomorphe*

Bredenkamp, Mrs C.L. M.Sc. Chief Scientific Officer. Assistant Curator: Public relations. Taxonomy of *Vitex*, *Phylica,* Rhamnaceae, Sterculiaceae and other related families

Germishuizen, G. M.Sc. Principal Scientist. Assistant Curator: Finances. Taxonomy of Polygonaceae, Fabaceae, Loranthaceae, Viscaceae

Herman, P.P.J. M.Sc. Principal Scientist. Assistant Curator: Personnel. Taxonomy of Asteraceae, Flora of northern provinces

Heymann, Mrs M.Z. T.E.Dip., B.A.(Education & History). Principal Specialized Auxiliary Services Officer. Assistant Curator: Services, loans, gifts and exchanges

Anderson, H.M. Ph.D. Principal Scientist. Palaeobotany, palaeogeography

Anderson, J.M. Ph.D. Specialist Scientist. Palaeobotany, palaeogeography

Archer, R.H. Ph.D. Scientist. Taxonomy of mainly Celastraceae, Euphorbiaceae

Archer (née Reid) Mrs C. M.Sc. Senior Scientist. Taxonomy of Cyperaceae, Restionaceae, Orchidaceae

Burgoyne, Ms P.M. M.Sc. Senior Scientific Officer. Plant identifications co-ordinator

Cloete, Mrs M. Dip.(Typing). Senior Provisioning Clerk. Specimen label typist

Dreyer, Miss L.L. M.Sc. Scientist. Taxonomy of Geraniaceae, Crassulaceae, Oxalidaceae

Fish, Mrs L. B.Sc. Chief Scientific Officer. Taxonomy of Poaceae. Plant collecting programme; supervising mounters

Glen, H.F. Ph.D. Senior Scientist. Taxonomy of trees and succulents, especially *Aloe*, herbarium for cultivated plants, and botanical collectors

Glen, Mrs R.P. M.Sc. Senior Scientific Officer. Taxonomy of ferns, water plants

Hoare (née Victor), Mrs J.E. B.Sc.(Hons.), H.Dip.Journ. Scientific Officer. Taxonomy of Rutaceae, Asclepiadaceae

Jordaan, Mrs M. M.Sc. Chief Scientific Officer. Taxonomy of Casuarinaceae—Connaraceae, *Maytenus*

Kgaditsi, W.T. Specialized Auxiliary Services Officer. Mounter, general assistant in cultivated plants section

Lephaka, M.G. Specialized Auxiliary Services Officer. Parcelling, pressing and general assistance

Makgakga, M.C. Senior Specialized Auxiliary Services Officer. Herbarium assistant, Wing B

Makgakga, K.S. Specialized Auxiliary Services Officer. Mounter of vascular plants

Makwarela, A. B.Sc. Scientific Officer

Marinus, Mrs E. Principal Specialized Auxiliary Services Officer. Herbarium assistant

Masombuka, Ms A. Specialized Auxiliary Services Officer. Herbarium assistant

Meyer, J.J. N.D.(Teaching). Scientific Officer. Herbarium assistant, Wing C

Netnou, Ms C. B.Sc. Scientific Officer

Nkoana, S. Scientific Officer

Perold, Mrs S.M. Ph.D. Taxonomy of Ricciaceae, Hepaticae (contract worker)

Phahla, T.J. Specialized Auxiliary Services Officer. Mounter of bryophytes and vascular plants

Ready, Mrs J.A. N.D.(Hort.). Senior Specialized Auxiliary Services Officer. Herbarium assistant, Wing D

Retief, Miss E. M.Sc. Senior Scientist. Pollen studies of Boraginaceae. Taxonomy of Boraginaceae, Verbenaceae, Lamiaceae, Asteraceae, Rubiaceae

Riddles, L. B.Sc. Scientific Officer

Sebothoma, P. Specialized Auxiliary Services Officer. Herbarium assistant

Smithies, Mrs S.J. M.Sc. Senior Scientific Officer. Taxonomy of Scrophulariaceae, Selaginaceae, Lobeliaceae

Steyn, Ms C.C. Principal Auxiliary Services Officer. Anatomy, palynology

Van Rooy, J. M.Sc. Senior Scientist. Taxonomy and biogeography of mosses; supervising bryophyte mounters

Veldman, Mrs J.M. Senior Provisioning Clerk. Herbarium administration

Welman, Miss W.G. M.Sc. Senior Scientist. Taxonomy of Convolvulaceae, Solanaceae, Cucurbitaceae, Campanulaceae, Asteraceae, Acanthaceae

DATA MANAGEMENT—PRETORIA

Arnold, T.H. M.Sc. Assistant Director. Computer application especially in taxonomy

Botha, Mrs A.G. Principal Specialized Auxiliary Services Officer. Secretary

De Wet, Mrs B.C. B.Sc.(Computer Science), B.A., H.D.L.S. Principal Datametrician

Evenwel, Mrs E. Specialized Auxiliary Services Officer. Quality control

Harris, Mrs B.J. Specialized Auxiliary Services Officer. Encoding, quality control

Joubert, Mrs M.A.E. Senior Data Typist

Kema, Ms N. Student (contract worker)

Stodart, Ms M. Student (contract worker)

Van Staden, Ms M. N.D.(Computer Data Processing). Assistant Datametrician

PRETORIA

Wolfson, Mrs M.M. Ph.D. Deputy Director. Physiology/Ecophysiology of Poaceae, carbon uptake metabolism, allocation in response to environmental and management stress

Clapperton, Mrs S. Typist
Du Plessis, Mrs E. Acting Head: Publications
Du Plessis, Mrs. H. Head: Research Herbarium Support Services
Liebenberg, Mrs E.J.L. Head: Administration
Potgieter, Mrs. E. Senior Librarian

PUBLICATIONS—PRETORIA

Du Plessis, Mrs E. B.Sc.(Hons.), S.E.D. Technical editor. Editing, translating, layout

Bopape, Mrs M.D. Senior Administration Clerk. Bookshop
Brink, Mrs S.S. Dip.(Typing). Chief Typesetter. Typesetting, layout, word processing
Leistner, O.A. D.Sc., F.L.S. Editing (contract worker)
Mapheza, T.P. Senior Storeman. Bookshop
Momberg, Mrs B.A. B.Sc.(Entomology & Zoology). Technical editor. Editing, layout
Mulvenna, Mrs J.M. Dip.(Typing). Typist. Word processing, typsetting (contract worker)

RESEARCH HERBARIUM SUPPORT SERVICES—PRETORIA

Du Plessis, Mrs H. M.Sc. Senior Scientist. Cytogenetics.

Condy, Ms G.S. M.A. Senior Industrial Technician. Botanical artist
Romanoswki, Mrs A.J. Dip.(Photography). Senior Industrial Technician (Photography). Scientific photographer

MARY GUNN LIBRARY—PRETORIA

Potgieter, Mrs E. B. Libr. Senior Librarian

Fourie, Mrs A. B.Libr. Assistant librarian (contract worker)
Louw, Ms A. Library assistant (contract worker)
Van der Walt, Ms A.M.E. Cataloguer (contract worker)

ADMINISTRATION—PRETORIA

Liebenberg, Mrs E.J.L. M.Sc. Chief Scientific Officer. Cytotaxonomy

Götzel, Mrs A. Senior Telecom. Operator
Kama, Mrs P.B. Administration Aid I
Kekana, Mrs M.R. Administration Aid I
Khumalo, N.P. Principal General Foreman. Supervisor: Office services
Koehne, Mrs R.W.R. Senior Registration Clerk
Makgobola, Mrs M.R. Administration Aid I
Maphuta, Mrs M.S. Administration Aid I
Martin, Ms M.A. Senior Administration Clerk
Phaala, M.C. Administration Aid I
Smuts, Mrs W.E. Administration Officer. Personnel
Tloubatla, J.M. Courier/Photocopy Machine Operator
Venter, W.A. N2(Technical). Principal General Foreman. Maintenance

ECOLOGY AND CONSERVATION SUBDIRECTORATE

CAPE TOWN

Rutherford, M.C. Ph.D., Dip.(Datamet.). Deputy Director

Davis, G.W. Ph.D. Assistant Director. Head: Ecology liaison. Stress and disturbance ecology
Nänni, Ms I. B.Sc., H.E.D. Head: Research Support Services
Reynolds, Ms P.Y. B.A., H.D.L.S., B.Proc. Senior Librarian

Bösenberg, J. de Wet B.Sc.(Hons.). Principal Scientific Officer. Cycad biology and conservation
Botha, P.A. N.H.D.(Hort.). Senior Scientific Officer. Tissue culture research, seed biology
Brown, N.A.C. Ph.D. Specialist Scientist. Seed biology research, plant growth regulators
De Lange, J.H. B.Sc.(Hort.), M.Sc.(Plant Physiology), D.Sc.(Agric.), Ph.D.(Bot.). Senior Specialist Scientist. Ecology, tissue culture, horticulture
Donaldson, J.S. M.Sc.(Entomology), PhD.(Zoology). Assistant Director. Cycad biology, plant/insect interactions, conservation biology
Hilton-Taylor, C. B.Sc.(Hons.)(Biological Sci.). Scientist. Threatened plants, biodiversity of arid regions
Hoffman, M.T. Ph.D. Senior Scientist. Disturbance and historical ecology
Hunter, Ms D.A. Senior Administration Clerk. Secretary
Jacobs, E.C. Specialized Auxiliary Services Officer. Laboratory Assistant. *Cyclopia*/Honeybush tea project
McDonald, D.J. Ph.D. Principal Scientist. Mountain vegetation, biogeography, conservation
Midgley, G.F. M.Sc. Principal Scientist. Plant stress physiology/ecology
Musil, C.F. Ph.D. Specialist Scientist. Plant stress physiology/ecology
O'Callaghan, M.G. Ph.D. Principal Scientist. Plant-climate interactions
Petersen, Ms A. Scientific Officer. Disturbance and historical ecology (contract worker)
Powrie, L.W. M.Sc. Chief Scientific Officer. Ecological databases: computer co-ordination
Rebelo, A.G. Ph.D.(Zoology). Senior Scientist. Conservation biology, biogeography
Wand, S.J.E. M.Sc.(Agric.). Scientist. Plant stress physiology/ecology

RESEARCH SUPPORT SERVICES—CAPE TOWN

Nänni, Ms I. B.Sc., H.E.D. Chief Scientific Officer

Boonzaier, I. Groundsman I
Bowler, Mrs M. Laboratory & Office Aid II
De Witt, D.M. Principal Specialized Auxiliary Services Officer. Scientific Assistant
Jagger, B.W. Principal Specialized Auxiliary Services Officer. Scientific Assistant
Parenzee, Ms H.A. Senior Administrative Assistant
Snyders, S.G. Specialized Auxiliary Services Officer. General Assistant

HARRY MOLTENO LIBRARY—CAPE TOWN

Reynolds, Ms P.Y. B.A., H.D.L.S., B.Proc., B. Bibl.(Hons.). Senior Librarian

Edwards, Mrs J. A.L.A.(UK). Cataloguer (contract worker)
Maqetuka, Ms N. Student (contract worker)

PUBLICATIONS BY THE STAFF
(1st April 1995–31st March 1996)

ANDERSON, H.M., HILLER, N. & GESS, R.W. 1995. *Archaeopteris* (Progymnospermopsida) from the Devonian of southern Africa. *Botanical Journal of the Linnean Society* 117: 305–320.

ARCHER, R. & CONDY, G. 1995. *Elaeodendron croceum*. *Flowering Plants of Africa* 54: 57–62, t. 2112.

ARCHER, R.H. & VAN WYK, A.E. 1995. Proposal to conserve the name *Cassine barbara* L. with a conserved type. *Taxon* 44: 435, 436.

ASHWELL, A.N. 1995. What role education? In A.B. Low & F.E. Jones, *The sustainable use and management of Renosterveld remnants in the Cape Floristic Kingdom*. Proceedings of a symposium. FCC Report 1994/5 Flora Conservation Committee, Botanical Society of South Africa, Kirstenbosch, Cape Town: 5–8.

BAXTER, J. & CROUCH, N. 1996. *Gerrardanthus tomentosus*: a rare member of the pumpkin family from KwaZulu-Natal. *PlantLife* 14: 11, 12.

BEYERS, J.B.P. 1995. A new species of *Trichogyne* from Namaqualand (Asteraceae). *Bothalia* 25: 107–109.

BEYERS, J.B.P. & VAN DER WALT, J.J.A. 1995. The generic delimitation of *Lachnaea* and *Cryptadenia* (Thymelaeaceae). *Bothalia* 25: 65–85.

BRITS, G.J., CUTTING, J.G.M., BROWN, N.A.C. & VAN STADEN, J. 1995. Environmental and hormonal regulation of seed dormancy and germination in Cape fynbos *Leucospermum* R.Br. (Proteaceae) species. A working model. *Plant Growth Regulation* 17: 181–193.

BROWN, N.A.C. 1995a. Conservation through cultivation. Plant-derived smoke and seed germination. *African Wildlife*, May–Oct.: 29.

BROWN, N.A.C. 1995b. Kirstenbosch Instant Smoke-Plus Seed Primer. *Hortagro* 2,1: 19.

BROWN, N.A.C. 1995c. Where there's smoke, there's seed. *The Australian Garden Journal*, Autumn: 48–50.

BROWN, N.A.C. & BOTHA, P.A. 1995. List of species in which treatment with smoke or aqueous smoke extract has been shown to give improved germination. *Veld & Flora* 81: 93.

BROWN, N.A.C., BOTHA, P.A. & PROSCH, D. 1995. Where there's smoke. *Garden* 120: 402–405. Royal Horticultural Society, London.

BURROWS, J.E. & CROUCH, N.R. 1995. New distribution records of South African pteridophytes (Pteridophyta). *Bothalia* 23: 236–238.

CAIRNCROSS, B., ANDERSON, J.M. & ANDERSON, H.M. 1995. Palaeoecology of the Triassic Molteno Formation, Karoo Basin, South Africa—sedimentological and palaeoecological evidence. *South African Journal of Geology* 98: 452–478.

CHESSELET, P., MÖSSMER, M. & SMITH, G.F. 1995. Research priorities in the succulent plant family Mesembryanthemaceae Fenzl. *South African Journal of Science* 91: 197–209.

CROUCH, N. & TARR, B. 1995. And all because the lady loves... *Crocosmia*. *Veld & Flora* 81: 79, 80.

DAVIS, G.W. (ed.) 1995a. *Bulletin of the Southern African Institute of Ecologists and Environmental Scientists* 14,1.

DAVIS, G.W. 1995b. Degradation for the better? *Bulletin of the Southern African Institute of Ecologists and Environmental Scientists* 14,2.

DAVIS, G.W. 1995c. Manipulating the medium. *Bulletin of the Southern African Institute of Ecologists and Environmental Scientists* 14,3: 1.

DAVIS, G.W. 1995d. International concern with functional aspects of biodiversity. *South African Journal of Science* 91: 61, 62.

DAVIS, G.W. & SOMERS, M. (eds) 1995. *Conservation of southern Africa's wild living resources: exploitation, sustainability and ethics*. Proceedings of a one day symposium, May 1995, hosted by the Southern African Institute of Ecologists and Environmental Scientists, the South African Wildlife Management Association, and the Marine Science Society of Southern Africa.

DEAN, W.R.J., HOFFMAN, M.T., KERLEY, G.I.H. & MILTON, S.J. 1995. Desertification in developed countries: in search of the silver bullet. *South African Journal of Science* 91: 213–215.

DEAN, W.R.J., HOFFMAN, M.T., MEADOWS, M.E. & MILTON, S.J. 1995. Desertification in the semi-arid Karoo, South Africa: review and reassessment. *Journal of Arid Environments* 30: 247–264.

DE LANGE, J.H. 1995. Saadlose bome: die oplossing vir bosbou? *Arbor*, October: 12.

DONALDSON, J.S. 1995a. An integrated effort to save South African cycads. *Plant Talk* 2: 13.

DONALDSON, J.S. 1995b. (ed.) *Cycad conservation in South Africa: issues, priorities and actions*. Cycad Society of South Africa, Pretoria.

DONALDSON, J.S. 1995c. Understanding cycad life histories: an essential basis for successful conservation. In J.S. Donaldson, *Cycad conservation in South Africa: issues, priorities and actions*, March 1995: 8–13. Cycad Society of South Africa, Pretoria.

DONALDSON, J.S. 1995d. Matched photographs as a means of assessing changes in cycad distribution and abundance. In J.S. Donaldson, *Cycad conservation in South Africa: issues, priorities and actions*, March 1995: 20–23. Cycad Society of South Africa, Pretoria.

DONALDSON, J.S. 1995e. The Winterberg cycad—surviving against the odds. *Veld & Flora* 81: 36–39.

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Bothalie 26,2: 201–210 (1996)

Guide for authors to Bothalia

This guide is updated when necessary and includes an index. **Important points and latest additions appear in bold type.**

Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the National Botanical Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

1 Editorial policy

1.1 *Bothalia* welcomes original papers dealing with flora and vegetation of southern Africa and related subjects. Full-length papers and short notes, as well as book reviews, are accepted.

1.2 **Page charges**: As stated in our notification included in volume 23,1 (May 1993), MSS submitted for publication in *Bothalia* after the 10th June 1993 are subject to payment of page charges of R125,00 per printed page, VAT included. The following are exempt from these charges: 1, NBI members; 2, persons/institutions who have been granted exemption by the Executive Committee of the NBI; 3, authors of contributions requested by the Editor; 4, contributors to the column '*FSA* contributions'. The Editor's decision on the number of pages is final. An invoice will be sent to the author, who must arrange for payment as soon as possible to NBI, Publications section, Private Bag X101, Pretoria 0001.

1.3 Articles are assessed by referees, both local and overseas. Authors are welcome to suggest possible referees to judge their work. Authors are responsible for the factual correctness of their contributions. *Bothalia* maintains an editorial board (see title page) to ensure that international standards are upheld.

2 Requirements for a manuscript

2.1 The original manuscript should be typed on one side of A4-size paper, double-spaced throughout (including abstract, tables, captions to figures, literature references, etc.) and have a margin of at least 30 mm all round. **Three** photocopies (**photocopied on both sides** of the paper to reduce weight for postage) of all items, including text, illustrations, tables and lists should be submitted, and the author should retain a complete set of copies. If the article was generated on a computer, a copy of the diskette should be submitted with the final (accepted) version (see 3).

2.2 Papers should conform to the general style and layout of recent issues of *Bothalia* (from volume 26 onwards).

2.3 Material should be presented in the following sequence: Title page with title, name(s) of author(s), keywords, abstract (and information that should be placed in a footnote on the title page, such as address(es) of author(s) and mention of granting agencies.

2.4 The sequence continues with Introduction and aims, Material and methods, Results, Interpretation (Discussion), Specimens examined (in revisions and monographs), Acknowledgements, References, Index of names (recommended for revisions dealing with more than about 15 species), Tables, Captions for figures and figures. In the case of short notes and book reviews, keywords and abstract are superfluous.

2.5 All pages must be numbered consecutively beginning with the title page to those with references, tables and captions to figures.

2.6 For notes on the use of hyphens and dashes see 3.10 to 3.12.

2.7 Special character: use your own word or code that is unique and self-explanatory, enclosed between ANGLE BRACKETS, e.g. <mu>m for µm. Please supply us with a list of the codes.

3 Requirements for diskettes/stiffies

(to be submitted only with final/accepted version)

3.1 data must be IBM compatible and written in **ASCII, or in Word for Windows from Windows 1; Word for MS-DOS from MSWord 3; WordPerfect 5 for DOS only; Windows Write 3 onwards.**

3.2 the original printout of the diskette should be supplied in **double line** spacing.

3.3 tables need not be placed on the diskette—a clearly laid out hard copy is adequate.

3.4 use a **non-breaking space** to keep two elements together on the same line, e.g. 3 500.

3.5 do not justify lines.

3.6 do not break words, except hyphenated words.

3.7 all lines, headings, keys, etc., should start flush at the margin, therefore **no indentations, footnotes or tabs** of any kind.

3.8 in **Word and WordPerfect**, italics and bold should be used where necessary.

3.9 paragraphs and headings are delineated by a carriage return (ENTER) but **no indentation.**

3.10 a hyphen is designated as one dash, with no space between the letter and the dash, e.g. ovate-lanceolate. See also 17.6.

3.11 an N-dash is typed as **three** hyphens with no space between the letter and the hyphen, e.g. 2- - -5 mm (typeset, it looks like this, 2–5 mm).

3.12 an M-dash is typed as **two** hyphens with no space between the letter and the hyphen, e.g. computers - - what a blessing! (typeset, it looks like this, computers—what).

3.13 do not use a double space between words, after commas, full stops, colons, semicolons or exclamation marks.

3.14 use lower case x as times sign, with one space on either side of the x, e.g. 2 x 3 mm.

3.15 use **single** (**not double**) opening and closing quotes, e.g. the so-called 'stiffy' refers to a rigid diskette.

3.16 keys—put only three leader dots before number and name of taxon (with one space before and one space after the first and last dot), regardless of how far or near the word is from the right margin, e.g. ... 1. R. ovata (see 13.18).

4 Author(s)

When there are several authors the covering letter should indicate clearly which of them is responsible for correspondence and, if possible, telephonically available while the article is being processed. The contact address and telephone number should be mentioned if they differ from those given on the letterhead.

5 Title

The title should be as concise and as informative as possible. In articles dealing with taxonomy or closely related subjects the family of the taxon under discussion (see also 13.2) should be mentioned in brackets but **author citations should be omitted from plant names** (see also 13.6).

6 Keywords

Up to 10 keywords (or index terms) should be provided in English in **alphabetical sequence**. The following points should be borne in mind when selecting keywords:

6.1 keywords should be unambiguous, internationally acceptable words and not recently coined little-known words.

6.2 they should be in a noun form and verbs should be avoided.

6.3 they should not consist of an adjective alone; adjectives should be combined with nouns.

6.4 they should not contain prepositions.

6.5 the singular form should be used for processes and properties, e.g. evaporation.

6.6 the plural form should be used for physical objects, e.g. augers.

6.7 location (province and/or country); taxa (species, genus, family) and vegetation type (community, veld type, biome) should be used as keywords.

6.8 keywords should be selected hierarchically where possible, e.g. both family and species should be included.

6.9 they should include terms used in the title.

6.10 they should answer the following questions:

6.10.1 what is the *active concept* in the document (activity, operation or process).

6.10.2 what is the *passive concept* or object of the active process (item on which the activity, operation or process takes place).

6.10.3 what is the means of accomplishment or how is the active concept achieved (technique, method, apparatus, operation or process).

6.10.4 what is the environment in which the active concept takes place (medium, location).

6.10.5 what are the independent (controlled) and dependent variables?

6.11 questions 6.10.1 to 6.10.3 should preferably also be answered in the title.

7 Abstract

7.1 Abstracts of no more than 200 words should be provided. Abstracts are of great importance and should convey the essence of the article.

7.2 They should refer to the geographical area concerned and, in taxonomic articles, mention the number of taxa treated. They should not contain information not appearing in the article.

7.3 In articles dealing with taxonomy or closely related subjects all taxa from the rank of genus downwards should be accompanied by their author citations (see also 13.6).

7.4 Names of new taxa and new combinations should not be italicized. If the article deals with too many taxa, only the important ones should be mentioned.

8 Table of contents

A table of contents should be given for all articles longer than about 15 typed pages, unless they follow the strict format of a taxonomic revision.

9 Acknowledgements

Acknowledgements should be kept to the minimum compatible with the requirements of courtesy. Please give all the initials of the person(s) you are thanking.

10 Literature references

In text

10.1 Literature references in the text should be cited as follows: 'Jones & Smith (1986) stated...', or '...(Jones & Smith 1986)' or (Ellis 1988: 67) when giving a reference simply as authority for a statement. For treatment of literature references in taxonomic papers see 14.

10.2 When **more than two authors** are involved in the paper use the name of the first author followed by *et al.*

10.3 When referring to more than one literature reference, they should be arranged **chronologically** and separated by a semicolon, e.g. (Nixon 1940; Davis 1976; Anon. 1981, 1984).

10.4 Titles of books and names of journals should preferably not be mentioned in the text. If there is good reason for doing so, they should be treated as described in 10.12 & 10.13.

10.5 Personal communications are given only in the text, not in the list of references. Please add the person's full initials to identify the person more positively, e.g. C. Boucher pers. comm.

In References at end of article

10.6 References of the same author are arranged in chronological sequence.

10.7 Where two or more references by the same author are listed in succession, the author's name is repeated with every reference, except in an obituary, where the name of the deceased in the list of publications (not in the references) is replaced by an N-dash.

10.8 All publications referred to in the text, including those mentioned in full in the treatment of correct names in taxonomic papers, but no others, and no personal communications, are listed at the end of the manuscript under the heading References.

10.9 The references are arranged alphabetically according to authors and chronologically under each author, with a, b, c, etc. added to the year, if the author has published more than one work in a year. **This sequence is retained when used in the text, irrespective of the chronology.**

10.10 If an author has published both on his own and as a senior author with others, the solo publications are listed first and after that, in strict alphabetical sequence, those published with one or more other authors.

10.11 Author names are typed in capitals.

10.12 Titles of journals and of books are written out in full and are italicized as follows: *Transactions of the Linnean Society of London* 5: 171–217, or *Biology and ecology of weeds*: 24.

10.13 Titles of books should be given as in *Taxonomic literature*, edn 2 by Stafleu & Cowan and names of journals as in the latest edition of *World list of scientific periodicals*.

10.14 Examples of references:

Collective book or Flora

BROWN, N.E. 1909. Asclepiadaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6,2: 518–1036. Reeve, London.
CUNNINGHAM, A.B. 1994. Combining skills: participatory approaches in biodiversity conservation. In B.J. Huntley, Botanical diversity in southern Africa. *Strelitzia* 1: 149–167. National Botanical Institute, Pretoria.

Book

DU TOIT, A.L. 1966. *Geology of South Africa*, 3rd edn, S.M. Haughton (ed.). Oliver & Boyd, London.
HUTCHINSON, J. 1946. *A botanist in southern Africa*. Gawthorn, London.

Journal

DAVIS, G. 1988. Description of a proteoid-restioid stand in Mesic Mountain Fynbos of the southwestern Cape and some aspects of its ecology. *Bothalia* 18: 279–287.
SMOOK, L. & GIBBS RUSSELL, G.E. 1985. Poaceae. *Memoirs of the Botanical Survey of South Africa* No. 51: 45–70.
STEBBINS, G.L. Jr 1952. Aridity as a stimulus to plant evolution. *American Naturalist* 86: 35–44.

In press, in preparation

TAYLOR, H.C. in press. *A reconnaissance of the vegetation of Rooiberg State Forest*. Technical Bulletin, Department of Forestry.
VOGEL, J.C. 1982. The age of the the Kuiseb river silt terrace at Homeb. *Palaeoecology of Africa* 15. In press.
WEISSER, P.J., GARLAND, J.F. & DREWS, B.K. in prep. Dune advancement 1937–1977 and preliminary vegetation succession chronology at Mlalazi Nature Reserve, Natal, South Africa. *Bothalia*.

Thesis

KRUGER, F.J. 1974. *The physiography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch.
MUNDAY, J. 1980. *The genus* Monechma *Hochst. (Acanthaceae tribe Justiciae) in southern Africa*. M.Sc. thesis, University of the Witwatersrand, Johannesburg.

Miscellaneous paper, report, unpublished article, technical note, congress proceedings

ANON. no date. *Eetbare plante van die Wolkberg*. Botanical Research Unit, Grahamstown. Unpublished.
BAWDEN, M.G. & CARROL, D.M. 1968. *The land resources of Lesotho*. Land Resources Study No. 3, Land Resources Division, Directorate of Overseas Surveys, Tolworth.
BOUCHER, C. 1981. Contributions of the Botanical Research Institute.

In A.E.F. Heydorn, *Proceedings of workshop research in Cape estuaries*: 105–107. National Research Institute for Oceanology, CSIR, Stellenbosch.
NATIONAL BUILDING RESEARCH INSTITUTE 1959. *Report of the committee on the protection of building timbers in South Africa against termites, woodboring beetles and fungi*, 2nd edn. CSIR Research Report No. 169.

11 Tables

11.1 Each table should be presented on a separate sheet and be assigned an Arabic numeral, i.e. the first table mentioned in the text is marked 'Table 1'.

11.2 In the captions of tables the word 'TABLE' is written in capital letters. See recent numbers of *Bothalia* for the format required.

11.3 Avoid vertical lines, if at all possible. Tables can often be reduced in width by interchanging primary horizontal and vertical heads.

12 Figures

12.1 Figures should be planned to fit, after reduction, into a width of either 80, 118 or 165 mm, with a maximum vertical length of 230 mm. Allow space for the caption in the case of figures that will occupy a whole page.

12.2 Line drawings, including graphs and diagrams, should be twice the size of the final reproduction and should be in jet-black Indian ink, preferably on fine Felix Schoeller parole or similar paper, 200 gsm, or tracing film. Lines should be bold enough **and letters/symbols large enough** to stand reduction.

12.3 Photographs should be of excellent quality on glossy paper with clear detail and moderate contrast, and they should be the same size as required in the journal.

12.4 Photograph mosaics should be submitted complete, the component photographs mounted neatly on a white **flexible card base (can be curved around drum of scanner)** leaving a narrow gap of uniform width (2 mm) between each print. Note that grouping photographs of markedly divergent contrast results in poor reproductions.

12.5 Lettering and numbering on all figures should be done in letraset, stencilling or a comparable method. If symbols are to be placed on a dark background it is recommended that black symbols are used on a small white disk ± 7 mm in diameter and placed in the **lower left hand corner** of the relevant photo.

12.6 If several illustrations are treated as components of a single composite figure they should be designated by **capital letters**.

12.7 Note that the word 'Figure' should be written out in full, both in the text and the captions and should begin with a capital 'F' **(but see 14.7 for taxonomic papers)**.

12.8 In the text the figure reference is then written as in the following example: 'The stamens (Figure 4A, B, C) are...'

12.9 In captions, 'FIGURE' is written in capital letters. Magnification of figures should be given for the size as submitted.

12.10 **Scale bars or scale lines should be used on figures.**

12.11 In figures accompanying taxonomic papers, voucher specimens should be given in the relevant caption.

12.12 Figures are numbered consecutively with Arabic numerals **in the order they are referred to in the text**. These numbers, as well as the author's name and an indication of the top of the figure, must be written in soft pencil on the back of all figures.

12.13 Captions of figures must **not** be pasted under the photograph or drawing.

12.14 Authors should indicate **in pencil** in the text where they would like the figures to appear.

12.15 Authors wishing to have the originals of figures returned must inform the editor in the original covering letter and must mark each original 'To be returned to author'.

12.16 Authors wishing to use illustrations already published must obtain written permission before submitting the manuscript and inform the editor of this fact.

12.17 Captions for figures should be collected together and typed **at the end of the MS** and headed *Captions for figures*.

12.18 It is strongly recommended that taxonomic articles include dot maps as figures to show the distribution of taxa. The dots used must be large enough to stand reduction to 80 mm (recommended size: letraset 5 mm diameter). **No open diamonds or open triangles should be used.**

12.19 Blank distribution maps of southern Africa, Africa and the world are available from the Bookshop, NBI Pretoria.

13 Text

13.1 As a rule, authors should use the names (but not of all authors of plant names—see 13.6) as listed by T.H. Arnold & B.C. de Wet (eds) in *Memoirs of the Botanical Survey of South Africa* No. 62.

13.2 Names of genera and infrageneric taxa are usually italicized, with the author citation (where relevant; see 13.6) not italicized. Exceptions include names of new taxa in the abstract, correct names given in the synopsis or in paragraphs on species excluded from a given supraspecific group in taxonomic articles; in checklists and in indices, where the position is reversed, correct names are not italicized and synonyms are italicized.

13.3 Names above generic level are not italicized.

13.4 In articles dealing with taxonomy and closely related subjects the complete scientific name of a plant (with author citation) should be given at the first mention in the text. The generic name should be abbreviated to the initial thereafter, except where intervening references to other genera with the same initial could cause confusion (see 16.6).

13.5 In normal text, Latin words are italicized, but in the synopsis of a species, Latin words such as *nom. nud.* are not italicized (see 14.3, 16.4, 17.9).

13.6 In accordance with Garnock-Jones & Webb (1996) in *Taxon* 45: 285, 286, authors of plant names are not to be added to plant names **except in taxonomic papers**. Names of authors of plant names should agree with the list published by the Royal Botanic Gardens, Kew, entitled, *Authors of plant names*, edited by R.K. Brummitt & C.E. Powell (1992).

13.7 Modern authors not included in the list should use their full name and initials when publishing new plant names. Other author names not in the list should be in agreement with the recommendations of the Code.

13.8 Names of authors of publications are written out in full except in the synonymy in taxonomic articles where they are treated like names of authors of plant names.

13.9 Names of plant collectors are italicized whenever they are linked to the number of a specimen. The collection number is also italicized, e.g. *Acocks 14407*.

13.10 Surnames beginning with 'De', 'Du' or 'Van' begin with a capial letter unless preceded by an initial.

13.11 For measurements use only units of the International System of Units (SI). **In taxonomic papers only mm and m, should be used; in ecological papers cm or m should be used.**

13.12 The use of '±' is preferred to c. or ca (see 17.7).

13.13 Numbers 'one' to 'nine' are spelled out in normal text, and from 10 onwards they are written in Arabic numerals.

13.14 In descriptions of plants, numerals are used throughout. Write 2.0–4.5 (not 2–4.5). When counting members write 2 or 3 (not 2–3), but 2–4.

13.15 Abbreviations should be used sparingly but consistently. No full stops are placed after abbreviations ending with the last letter of the full word (e.g. edition = edn; editor = ed.); after units of measure; after compass directions; after herbarium designations; **after countries, e.g. USA and after well-known institutions, e.g. CSIR**.

13.16 Apart from multi-access keys, indented keys should be used with couplets numbered 1a–1b, 2a–2b, etc. (without full stops thereafter).

13.17 Keys consisting of a single couplet have no numbering.

13.18 Manuscripts of keys should be presented as in the following example:

1a Leaves closely arranged on an elongated stem; a submerged aquatic with only the capitula exserted ... 1b. *E. setaceum* var. *pumilum*
1b Leaves in basal rosettes; stems suppressed; small marsh plants, ruderals or rarely aquatics:
2a Annuals, small, fast-growing pioneers, dying when the habitat dries up; capitula without coarse white setae; receptacles cylindrical:
3a Anthers white ... 2. *E. cinereum*
3b Anthers black ... 3. *E. nigrum*
2b Perennials, more robust plants; capitula sparsely to densely covered with short setae:

13.19 Herbarium voucher specimens should be referred to wherever possible, not only in taxonomic articles.

14 Species treatment in taxonomic papers

14.1 The procedure to be followed is illustrated in the example (17.9), which should be referred to, because not all steps are described in full detail.

14.2 The correct name (not italicized) is to be followed by its author citation (italicized) and the full literature reference, with the name of the publication written out in full (not italicized).

14.3 Thereafter all literature references, including those of the synonyms, should only reflect author, page and year of publication, e.g. C.E. Hubb. in Kew Bulletin 15: 307 (1960); Boris et al.: 14 (1966); Boris: 89 (1967); Sims: t. 38 (1977); Sims: 67 (1980).

14.4 The description and the discussion should consist of paragraphs commencing, where possible, with italicized leader words such as *flowering time, diagnostic characters, distribution* and *habitat*.

14.5 When more than one species of a given genus is dealt with in a paper, the correct name of each species should be prefixed by a sequential number followed by a full stop. Infraspecific taxa are marked with small letters, e.g. 1b., 12c., etc.

14.6 Names of authors are written as in 13.6, irrespective of whether the person in question is cited as the author of a plant name or of a publication.

14.7 The word 'figure' is written as 'fig.', and 't.' is used for both 'plate' and 'tablet' (but see 12.7 for normal text).

14.8 Literature references providing good illustrations of the species in question may be cited in a paragraph commencing with the word Icones followed by a colon. This paragraph is given after the last paragraph of the synonymy, see 17.9.

15 Citation of specimens

15.1 Type specimen in synopsis: the following should be given (if available): country (if not in RSA), province, grid reference (at least for new taxa), locality as given by original collector, modern equivalent of collecting locality in square brackets (if relevant, e.g. Port Natal [now Durban]), **quarter-degree square,** date of collection (optional), collector's name and collecting number (both italicized).

15.2 The abbreviation *s.n.* (*sine numero*) is given after the name of a collector who usually assigned numbers to his collections but did not do so in the specimen in question. The herbaria in which the relevant type(s) are housed are indicated by means of the abbreviations given in the latest edition of *Index Herbariorum.*

15.3 The holotype (holo.) and its location are mentioned first, followed by a semicolon, the other herbaria are arranged alphabetically, separated by commas.

15.4 Authors should indicate by means of an exclamation mark (!) which of the types have been personally examined.

15.5 If only a photograph or microfiche was seen, write as follows: *Anon. 422* (X, holo.–BOL, photo.!).

15.6 Lectotypes or neotypes should be chosen for correct names without a holotype. It is not necessary to lectotypify synonyms.

15.7 When a lectotype or a neotype are newly chosen, this should be indicated by using the phrase 'here designated' (see 17.9). If reference is made to a previously selected lectotype or neotype, the name of the designating author and the literature reference should be given. In cases where no type was cited, and none has subsequently been nominated, this may be stated as 'not designated'.

15.8 In brief papers mentioning only a few species and a few cited specimens the specimens should be arranged according to the grid reference system: Provinces/ countries (typed in capitals) should be cited in the following order: Namibia, Botswana, **Northern Province** (previously Northern Transvaal), **North-West** (previously northeastern Cape and southwestern Transvaal), **Gauteng** (previously PWV), **Mpumalanga** (previously Eastern Transvaal), **Free State** (previously Orange Free State), Swaziland, **KwaZulu-Natal**, Lesotho, and **Northern Cape, Western Cape and Eastern Cape** (see Figure 1, p. 208).

15.9 Grid references should be cited in numerical sequence.

15.10 Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order, i.e (–AC) precedes (–AD), etc. Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter-degree references must be repeated for each specimen cited.

15.11 The relevant international code of the herbaria in which a collection was seen should be given in brackets after the collection number; the codes are separated by commas. The following example will explain the procedure:

KWAZULU-NATAL.—2731 (Louwsburg): 16 km E of Nongoma, (–DD), *Pelser 354* (BM, K, PRE); near Dwarsrand, *Van der Merwe 4789* (BOL, M). 2829 (Harrismith): near Groothoek, (–AB), *Smith 234*; Koffiefontein, (–AB), *Taylor 720* (PRE); Cathedral Peak Forest Station, (–CC), *Marriot 74* (KMG); Wilgerfontein, *Roux 426.* Grid ref. unknown: Sterkstroom, *Strydom 12* (NBG).

15.12 For records from outside southern Africa authors should use degree squares without names, e.g.:

KENYA.—0136: Nairobi plains beyond race course, *Napier 485.*

15.13 Monographs and revisions: in the case of all major works of this nature it is assumed that the author has investigated the relevant material in all major herbaria and that he has provided the specimens seen with determinavit labels. It is assumed further that the author has submitted distribution maps for all relevant taxa and that the distribution has been described briefly in words in the text. Under the heading 'Vouchers' no more than five specimens should be cited, indicating merely the collector and the collector's number (both italicized). Specimens are alphabetically arranged according to collector's name. If more than one specimen by the same collector is cited, they are arranged numerically and separated by a **comma**. The purpose of the cited specimens is not to indicate distribution but to convey the author's concept of the taxon in question.

15.14 The herbaria in which the specimens are housed are indicated by means of the abbreviation given in the latest edition of *Index Herbariorum.* They are given between brackets, arranged alphabetically and separated by commas behind every specimen as in the following example:

Vouchers: *T.H. Arnold 64* (PRE); *Fisher 840* (NH, NU, PRE); *Flanagan 831* (GRA, PRE), *840* (NH, PRE); *Marloth 4926* (PRE, STE); *Schelpe 6161, 6163, 6405* (BOL); *Schlechter 4451* (BM, BOL, GRA, K, PRE).

15.15 If long lists of specimens are given, they must be listed together before Acknowledgements under the heading *Specimens examined.* They are arranged alphabetically by the collector's name and then numerically for each collector. The species is indicated in brackets by the number that was assigned to it in the text and any infraspecific taxa by a small letter. If more than one genus is dealt with in a given article, the first species of the first genus mentioned is indicated as 1.1. This is followed by the international herbarium designation. Note that the name of the collector and the collection number are italicized:

Acocks 12497 (2.1b) BM, K, PRE; *14724* (1.13a) BOL, K, P. *Archer 1507* (1.4) BM, G. *Burchell 2847* (2.8c) MB, K. *Burman 2401* (3.3) MO, S. *B.L. Burtt 789* (2.6) B, KMG, STE.

16 Synonyms

16.1 In a monograph or a revision covering all of southern Africa, all synonyms based on types of southern African origin, or used in southern African literature, should be included.

16.2 Illegitimate names are designated by *nom. illeg.* after the reference, followed by *non* with the author and date, if there is an earlier homonym.

16.3 *Nomina nuda (nom. nud.)* and invalidly published names are excluded unless there is a special reason to cite them, for example if they have been used in prominent publications.

16.4 In normal text Latin words are italicized, but in the synopsis of a species Latin words such as *nom. nud.*, *et al.* are not italicized (see 13.5, 14.3, 17.9).

16.5 Synonyms should be arranged chronologically into groups of nomenclatural synonyms, i.e. synonyms based on the same type, and the groups should be arranged chronologically by basionyms, except for the basionym of the correct name which is dealt with in the paragraph directly after that of the correct name.

16.6 When a generic name is repeated in a given synonymy it should be abbreviated to the initial, except where intervening references to other genera with the same initial could cause confusion (see 13.4).

17 Description and example of species treatment

17.1 Descriptions of all taxa of higher plants should, where possible, follow the sequence: Habit; sexuality; underground parts (if relevant). *Indumentum* (if it can be easily described for the whole plant). *Stems/branches. Bark. Leaves*: arrangement, petiole absent/present, pubescence; blade: shape, size, apex, base, margin; midrib: above/ below, texture, colour; petiole; stipules. *Inflorescence*: type, shape, position; bracts/bracteoles. *Flowers*: shape, sex. *Receptacle. Calyx. Corolla. Disc. Androecium. Gynoecium. Fruit. Seeds. Chromosome number. Conservation status*. Figure (word written out in full) number.

17.2 As a rule, shape should be given before measurements.

17.3 In general, if an organ has more than one of the parts being described, use the plural, otherwise use the singular, for example, petals of a flower but blade of a leaf.

17.4 Language must be as concise as possible, using participles instead of verbs.

17.5 Dimension ranges should be cited as in 17.9.

17.6 Care must be exercised in the use of dashes and hyphens. A *hyphen* is a short stroke joining two syllables of a word, e.g. ovate-lanceolate or sea-green, with no space between the letter and the stroke. An *N-dash* (*en*) is a longer stroke commonly used instead of the word 'to' between numerals, '2–5 mm long' (do not use it between words but rather use the word 'to', e.g. 'ovate to lanceolate'); it is produced by typing **three** hyphens next to each other. An *M-dash* (*em*) is a stroke longer than an N-dash and is used variously, e.g. in front of a subspecific epithet instead of the full species name; it is produced by typing **two** hyphens next to one another.

17.7 The use of '±' is preferred to c. or ca when describing shape, measurements, dimensions, etc. (see 13.12).

17.8 **The decimal point replaces the comma in all units of measurement**, e.g. leaves 1.0–1.5 mm long.

17.9 Example:

1. **Englerophytum magalismontanum** *(Sond.) T.D.Penn.* The genera of Sapotaceae: 252 (1991). Type: Gauteng, Magaliesberg, *Zeyher 1849* (S, holo.–BOL, photo.!).

Bequaertiodendron magalismontanum (Sond.) Heine & Hemsl.: 307 (1960); Codd: 72 (1964); Elsdon: 75 (1980).

Chrysophyllum magalismontanum Sond.: 721 (1850); Harv.: 812 (1867); Engl.: 434 (1904); Bottmar: 34 (1919). *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.: 105 (1958); Justin: 97 (1973).

Chrysophyllum argyrophyllum Hiern: 721 (1850); Engl.: 43 (1904). *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr.: 37 (1958); Justin et al.: 98 (1973). Types: Angola, *Welwitsch 4828* (BM!, lecto., here designated; PRE!); Angola, *Welwitsch 4872* (BM!).

Chrysophyllum wilmsii Engl.: 4, t. 16 (1904); Masonet: 77 (1923); Woodson: 244 (1937). *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr.: 39 (1958); Justin: 99 (1973). Type: Mpumalanga, Magoebaskloof, *Wilms 1812* [B, holo.†; K!, P!, lecto., designated by Aubrév. & Pellegr.: 38 (1958), PRE!, S!, W!, Z!].

Bequaertiodendron fruticosa De Wild.: 37 (1923), non Bonpl.: 590 (1823); D.Bakker: 167 (1929); H.Fr.: 302 (1938); Davy: 640 (1954); Breytenbach: 117 (1959); Clausen: 720 (1968); Palmer: 34 (1969). Type: Mpumalanga, Tzaneen Dist., *Granville 3665* (K, holo.!; G!, P!, PRE!, S!).

B. fragrans auct. non Oldemann: Glover: 149, t. 19 (1915); Henkel: 226 (1934); Stapelton: 6 (1954).

Icones: Harv.: 812 (1867); Henkel: t. 84 (1934?); Codd: 73 (1964); Palmer: 35 (1969).

Woody perennial; main branches up to 0.4 m long, erect or decumbent, grey woolly-felted, leafy. *Leaves* linear to oblanceolate, 3–10(–23) × 1.0–1.5(–4.0) mm, obtuse, base broad, half-clasping. *Heads* heterogamous, campanulate, 7–8 × 5 mm, solitary, sessile at tip of axillary shoots; involucral bracts in 5 or 6 series, inner exceeding flowers, tips subopaque, white, very acute. *Receptacle* nearly smooth. *Flowers* ± 23–30, 7–11 male, 16–21 bisexual, yellow, tipped pink. *Achenes* ± 0.75 mm long, elliptic. *Pappus* bristles very many, equalling corolla, scabridulous. *Chromosome number*: 2n = 22. Figure 23B.

18 New taxa

18.1 The name of a new taxon must be accompanied by at least a Latin diagnosis. Authors should not provide full-length Latin descriptions unless they have the required expertise in Latin at their disposal.

18.2 It is recommended that descriptions of new taxa be accompanied by a good illustration (line drawing or photograph) and a distribution map.

18.3 Example:

109. **Helichrysum jubilatum** *Hilliard*, sp. nov. *H. alsinoidei* DC. affinis, sed foliis ellipticis (nec spatulatis), inflorescentiis compositis a foliis non circumcinctis, floribus femineis numero quasi dimidium hermaphroditorum

aequantibus (nec capitulis homogamis vel floribus femineis 1–3 tantum) distinguitur.

Herba annua e basi ramosa; caules erecti vel decumbentes, 100–250 mm longi, tenuiter albo-lanati, remote foliati. *Folia* plerumque 8–30 × 5–15 mm, sub capitulis minora, elliptica vel oblanceolata, obtusa vel acuta, mucronata, basi semi-amplexicauli, utrinque cano-lanato- arachnoidea. *Capitula* heterogama, campanulata, 3.5–4.0 × 2.5 mm, pro parte maxima in paniculas cymosas terminales aggregata; capitula subterminalia interdum solitaria vel 2 vel 3 ad apices ramulorum nudorum ad 30 mm longorum. *Bracteae involucrales* 5-seriatae, gradatae, exteriores pellucidae, pallide stramineae, dorso lanatae, seriebus duabus interioribus subaequalibus et flores quasi aequantibus, apicibus obtusis opacis niveis vix radiantibus. *Receptaculum* fere laeve. *Flores* ± 35–41. *Achenia* 0.75 mm longa, pilis myxogenis praedita. *Pappi* setae multae, corollam aequantes, apicibus scabridis, basibus non cohaerentibus.

TYPE.—Northern Cape, 2817 (Vioolsdrif): Richtersveld, (–CC), ± 5 miles E of Lekkersing on road to Stinkfontein, kloof in hill south of road, annual, disc whitish, 7-11-1962, *Nordenstam 1823* (S, holo.; E, NH, PRE).

19 New provinces of South Africa (Oct. 1996)

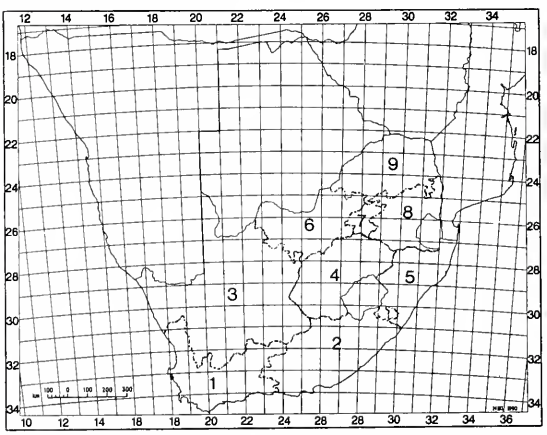

FIGURE 1.—1, Western Cape; 2, Eastern Cape; 3, Northern Cape; 4, Free State (previously Orange Free State); 5, KwaZulu-Natal; 6, North-West (previously northeastern Cape and southwestern Transvaal); 7, Gauteng (previously PWV); 8, Mpumalanga (previously Eastern Transvaal); 9, Northern Province (previously Northern Transvaal).

20 Proofs

Only page proofs are normally sent to authors. They should be corrected in red ink and be returned to the editor **as soon as possible.**

21 Reprints

Authors receive 100 reprints free. If there is more than one author, this number will have to be shared between them.

22 Documents consulted

Guides to authors of the following publications were made use of in the compilation of the present guide: *Annals of the Missouri Botanic Garden, Botanical Journal of the Linnean Society, Flora of Australia, Smithsonian Contributions to Botany, South African Journal of Botany* (including instructions to authors of taxonomic papers), *South African Journal of Science.*

23 Address of editor

Manuscripts should be submitted to: The Editor, Bothalia, National Botanical Institute, Private Bag X101, Pretoria 0001.

24 *FSA* contributions

24.1 Figures and text must conform to *Bothalia* format.

24.2 These articles will be considered as a full contribution to the *Flora of southern Africa* and will be listed as published in the 'Plan of *Flora of southern Africa*', which appears in all issues of the *FSA* series.

INDEX

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Volume 26,2 October 1996

CONTENTS

Abstracted, indexed or listed in • AETFAT Index • AGRICOLA • BIOSIS: *Biological Abstracts/RRM* • CAB: *Herbage Abstracts, Field Crop Abstracts* • CABS: *Current Advances in Plant Science* • ISI: *Current Contents, Scisearch, Research Alert* • *Kew Record of Taxonomic Literature* • *Taxon*: Reviews and notices.

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